R&S®SMW-B14/-K71/-K72/-K74/-K75/-K76
Fading Simulation
User Manual
Fading Simulator, Dynamic Fading, Enhanced Fading Models, MIMO-Fading/Routing, Higher Order MIMO, Multiple Entities

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Test & Measurement

User Manual

ROHDE&SCHWARZ

This document describes the following software options:

- R&S®SMW-B14/-K71/-K72/-K74/-K75/-K76
  1413.1500.02, 1413.3532.xx, 1413.3584.xx, 1413.3632.xx, 1413.9576.xx, 1413.9624.xx

This manual describes firmware version FW 3.20.324.xx and later of the R&S®SMW200A.

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The following abbreviations are used throughout this manual: R&S®SMW200A is abbreviated as R&S SMW, R&S®WinIQSIM2 is abbreviated as R&S WinIQSIM2; the license types 02/03/07/11/13/16/12 are abbreviated as xx.

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1 Preface

1.1 About this Manual

This User Manual is a supplement to the user manual for the base unit and provides all the information **specific to the Fading Simulator**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S SMW User Manual.

The main focus in this manual is on the provided settings and the tasks required to generate a signal. The following topics are included:

- **Welcome to the Fading Simulator R&S SMW-B14/-K71/-K72/-K74/-K75**
  Introduction to and getting familiar with the option
- **About the Fading Simulator**
  Background information on basic terms and principles in the context of the signal generation
- **Configuration and Settings**
  A concise description of all functions and settings available to configure the signal generation with their corresponding remote control command; the description is divided into several sections:
  - Fading Settings
  - Signal Routing (non-MIMO) Settings
  - Multiple Input Multiple Output (MIMO)
  - Summation Ratio A/B
- **Remote Control Commands**
  Remote commands required to configure and perform signal generation in a remote environment, sorted by tasks
  (Commands required to set up the instrument or to perform common tasks on the instrument are provided in the main R&S SMW User Manual)
  Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **Annex**
  Reference material
- **List of remote commands**
  Alphabetical list of all remote commands described in the manual
- **Index**

1.2 Documentation Overview

The user documentation for the R&S SMW consists of the following parts:

- Getting Started printed manual
- Online Help system on the instrument, incl. Tutorials

- Documentation CD-ROM with:
  - Getting Started
  - Online help system (Web Help and `*.chm`) as a standalone help
  - User Manuals for base unit and options
  - Service manual
  - Data sheet and product brochure
  - Links to useful sites on the Rohde & Schwarz internet

Online Help

The Online Help is embedded in the software. It offers quick, context-sensitive access to the complete information needed for operation and programming. The online help contains help on operating the R&S SMW and all available options.

Getting Started

The Getting Started is delivered with the instrument in printed form and in PDF format on the documentation CD. It provides the information needed to set up and start working with the instrument. Basic operations and typical signal generation examples are described. Safety information is also included.

This manual is available in several languages. You can download these documents from the Rohde & Schwarz website, on the R&S SMW product page at http://www.rohde-schwarz.com/product/SMW200A.html > Downloads > Manuals.

User Manual

User manuals are provided for the base unit and each additional (software) option.

The User Manual for the base unit is a supplement to the Getting Started manual and provides basic information on operating the R&S SMW in general. In this manual, all instrument functions are described in detail. Furthermore, it provides a complete description of the remote control commands with programming examples. An introduction to remote control is provided, as well as information on maintenance, instrument interfaces and troubleshooting.

In the user manuals for the individual software options, the specific instrument functions of this option are described in detail. For additional information on default settings and parameters, refer to the data sheets. Basic information on operating the R&S SMW is not included in these user manuals.

The user manuals are available in PDF format - in printable form - on the Documentation CD-ROM delivered with the instrument.

All user manuals are also available for download from the Rohde & Schwarz website, on the R&S SMW product page at http://www.rohde-schwarz.com/product/SMW200A.html > Downloads > Manuals.

Service Manual

The service manual is available in PDF format on the CD delivered with the instrument. It describes how to check compliance with rated specifications, instrument function,

repair, troubleshooting and fault elimination. It contains all information required for repairing the R&S SMW by replacing modules.

Release Notes

The release notes describe the installation of the firmware, new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes.

The latest versions are available for download from the R&S SMW product page, at http://www.rohde-schwarz.com/product/SMW200A.html > Downloads > Firmware.

Web Help

The web help provides online access to the complete information on operating the R&S SMW and all available options, without downloading. The content of the Web Help corresponds to the user manuals for the latest product version.

The web help is available from the R&S SMW product page, at http://www.rohde-schwarz.com/product/SMW200A.html > Downloads > Web Help.

Tutorials

A set of tutorials is embedded in the software. The tutorials offer guided examples and demonstrations on operating the R&S SMW.

Application Notes

Application notes, application cards, white papers and educational notes are further publications that provide more comprehensive descriptions and background information.

A subset of application notes is provided on the documentation CD-ROM delivered with the instrument.

The latest versions are available for download from the Rohde & Schwarz website, at http://www.rohde-schwarz.com/appnotes.

1.3 Conventions Used in the Documentation

1.3.1 Typographical Conventions

The following text markers are used throughout this documentation:

Convention	Description
"Graphical user interface elements"	All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks.
KEYS	Key names are written in capital letters.

Convention	Description
`File names, commands, program code`	File names, commands, coding samples and screen output are distinguished by their font.
Input	Input to be entered by the user is displayed in italics.
Links	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

1.3.2 Conventions for Procedure Descriptions

When describing how to operate the instrument, several alternative methods may be available to perform the same task. In this case, the procedure using the touchscreen is described. Any elements that can be activated by touching can also be clicked using an additionally connected mouse. The alternative procedure using the keys on the instrument or the on-screen keyboard is only described if it deviates from the standard operating procedures.

The term "select" may refer to any of the described methods, i.e. using a finger on the touchscreen, a mouse pointer in the display, or a key on the instrument or on a keyboard.

1.3.3 Notes on Screenshots

When describing the functions of the product, we use sample screenshots. These screenshots are meant to illustrate as much as possible of the provided functions and possible interdependencies between parameters. The shown values may not represent realistic test situations.

The screenshots usually show a fully equipped product, that is: with all options installed. Thus, some functions shown in the screenshots may not be available in your particular product configuration.

2 Welcome to the Fading Simulator

The hardware option R&S SMW-B14 in combination with the firmware applications R&S SMW-K71/-K72/-K74/-K75/-K76 add functionality to simulate fading propagation conditions.

The most important R&S SMW-B14/-K71/-K72/-K74/-K75/-K76 features at a glance:

- Simulation of real time fading conditions in SISO and MIMO modes.
- Main characteristics in SISO mode:
  - Maximal bandwidth B_{max} = 160 MHz
  - Up to 20 dynamic fading paths in SISO mode in two independent channels
- Support of versatile MIMO configurations, like 2x2, 2x8 and 4x4 MIMO channels with up to 32 MIMO channels
  Main characteristics of the 4x4 MIMO mode:
  - 20 paths per MIMO channel
  - Sampling rate in 4x4 MIMO mode f_{Sys} = 100 MHz
  - Maximal bandwidth up to B_{max} = 160 MHz, depending on the MIMO mode
- Simulation of multiple entity MIMO scenarios, like 4x2x2 MIMO or 8xSISO (8x1x1) configurations
- A wide range of presets based on the test specifications of the major mobile radio standards
- Realistic simulation of frequency hopping conditions
- Graphical presentation of the defined fading paths

This user manual contains a description of the functionality that the application provides, including remote control operation.

All functions not discussed in this manual are the same as in the base unit and are described in the R&S SMW user manual. The latest version is available for download at the product homepage.

Installation

You can find detailed installation instructions in the delivery of the option or in the R&S SMW Service Manual.

2.1 Accessing the Fading Simulator

To access and configure the "Fading Simulator" settings

► In the block diagram of the R&S SMW, select "Fading > Fading Settings".

A dialog box opens that display the provided general settings.

The signal generation is not started immediately. To start signal generation with the default settings, select "Fading > State > On".

For information, see:

- chapter 3, "About the Fading Simulator", on page 17
- chapter 4, "Fading Settings", on page 24
- chapter 5, "Signal Routing (non-MIMO) Settings", on page 81
- chapter 6, "Multiple Input Multiple Output (MIMO)", on page 84
- chapter 7, "Summation Ratio A/B", on page 116

2.2 Scope

Tasks (in manual or remote operation) that are also performed in the base unit in the same way are not described here.

In particular, this includes:

- Managing settings and data lists, i.e. storing and loading settings, creating and accessing data lists, accessing files in a particular directory, etc.
- Information on regular trigger, marker and clock signals as well as filter settings, if appropriate.
- General instrument configuration, such as checking the system configuration, configuring networks and remote operation
- Using the common status registers

For a description of such tasks, see the R&S SMW user manual.

3 About the Fading Simulator

Equipped with the required options, the R&S SMW allows you to superimpose real time fading on the baseband signal at the output of the baseband block. When fitted with all of the possible options, available are up to 20 fading paths in SISO mode as well as per MIMO channel in 4x4 MIMO mode.

3.1 Required Options

The equipment layout for simulating fading effects in non-MIMO configurations:

- option Baseband Generator (R&S SMW-B10) per signal path
- option Baseband main module, one/two I/Q paths to RF (R&S SMW-B13/B13T)
- option Fading Simulator (R&S SMW-B14) per signal path
  (sufficient for simulation of fading paths with standard delay and paths with enhanced resolution)
- additional options that extend the fading functionality:
  - option Dynamic Fading (R&S SMW-K71) per signal path
    (required for the simulation of dynamic fading conditions, like birth death propagation, moving propagation, two channel interferes and high speed train conditions)
  - option Extended statistic functions (R&S SMW-K72) per signal path
    (required for additional fading profiles and some of the predefined test scenarios)

Refer to the instrument's specifications for more information.

The equipment layout for simulating fading effects in MIMO configurations:

- two options Baseband Generator (R&S SMW-B10)
- option two I/Q paths to RF (R&S SMW-B13T)
- at least two options Fading Simulator (R&S SMW-B14)
- option MIMO Fading (R&S SMW-K74)
  (required for the configuration of MIMO scenarios, like 1x2x8 or 1x4x4 scenarios)
- option Higher Oreder MIMO (R&S SMW-K75)
  (required for the configuration of higher order MIMO scenarios, like 4x2x2)
- option Multiple Entities (R&S SMW-K76)
  (required for the configurations with more than two entities, like 8x1x1 sceanrios)

Refer to the instrument's specifications for more information.

3.2 Overview of the Functions Provided by the Fading Simulator

This section summarizes the key functions of the fading simulator to emphasize the way it is suitable for test setups during research, development, and quality assurance involving mobile radio equipment.

Flexible configuration for support of different test scenarios

You can use the provided fading channels and configure them differently for different test scenarios. Use the same input signal and two separate output signals, for example, to simulate a frequency diversity. Or use separate input signals and sum them after fading, to simulate a network handover, for instance.

See also chapter 5, "Signal Routing (non-MIMO) Settings", on page 81.

Predefined fading scenarios

The fading simulator is equipped with a wide range of presets based on the test specifications of the major mobile radio standards. For more complex tests, all of the parameters of the supplied fading configurations can be user-defined as required.

See also "Standard / Test Case" on page 27.

Repeatable test conditions

To ensure the repeatability of the tests, the fading process is always initiated from a defined starting point.

See also chapter 4.2, "Restart Settings", on page 34.

Realistic simulation of frequency hopping conditions

Frequency hopping which builds upon the prior fading process after a frequency hop allows realistic simulation of frequency hopping conditions.

See also "Freq. Hopping Mode" on page 33

Graphical presentation

The path graph displays the current defined fading paths and supports you to configure the desired fading channel.

See also chapter 4.5, "Path Graph", on page 51.

Simulation of diverse fading effects

During transmission of a signal from the transmitter to the receivers, diverse fading effects occur. In the fading simulator, you can simulate these effects separately or in combination.

Using the provided fading configurations for example, you can define up to 20 fading paths with different delays as they would occur on a transmission channel due to different propagation paths.

See also chapter 4.4, "Path Table", on page 40.

Predefined fast fading profile for different fading scenarios

The fading simulator provides a wide range of fast fading profiles. You can define the fading conditions per generated fading path. The fast fading profiles simulate fast fluctuations of the signal power level which arise due to variation between constructive and destructive interference during multipath propagation.

See also "Configuration" on page 27 and "Profile" on page 44

Simulation of slow fading effect

"Lognormal" and "Suzuki Fading" are slow fading profiles suitable to simulate slow level changes which can occur, due to shadowing effects (for example tunnels, buildings blocks, hills etc.).

See also chapter 4.4, "Path Table", on page 40.

Simulation of dynamic configurations

Delay variations (whether sudden or slow) do not become important until we reach the fast modulation standards, such as the 3GPP FDD or EUTRA/LTE standards. The delay variations start to play a role if they are on the order of magnitude of the transmitted symbols so that transmission errors can arise.

The provided dynamic configurations simulate dynamic propagation in conformity with test cases defined in the 3GPP and MediaFlo specifications.

See also:

- chapter 4.6, "Birth Death Propagation", on page 52
- chapter 4.7, "Moving Propagation", on page 57
- chapter 4.9, "High Speed Train", on page 71
- chapter 4.8, "Two Channel Interferer", on page 65

Insertion loss for correct drive at the baseband level

The insertion loss is a method to provide a drive reserve and to keep the output power constant. In the R&S SMW, the used insertion loss is not a fixed value but is dynamically adjusted for different measurement tasks, i.e. you can define the way the range for insertion loss is determined.

See also chapter 4.3, "Insertion Loss Configuration, Coupled Parameters and Global Fader Coupling", on page 35.

Support of versatile MIMO configurations

See also chapter 6, "Multiple Input Multiple Output (MIMO)", on page 84.

3.3 Definition of Commonly Used Terms

Fading Simulator

Each option R&S SMW-B14 provides the hardware of one fading simulator, i.e. for each installed fading simulator option, one hardware FADER board is available. One, two or four fading simulators can be installed. The provided fading functionality, however, depends on the installed firmware options.

Fading channel

A fading channel is the term describing the signal between a transmit (Tx) and a receive (Rx) antenna, scattered in various paths.

In a 2x2 MIMO fading configuration, there are four fading channels between the transmit (Tx) and the receive (Rx) antennas. In this description, each fading channel is represent as a block with name following the naming convention "$F_{<Tx><Rx>}$", where Tx and Rx are the antennas (e.g. A and B in a 2x2 MIMO configuration).

An instrument equipped with the R&S SMW-K74 option can simulates up to 16 MIMO fading channels, as it is for instance required for 4x4 MIMO receiver tests.

If the option R&S SMW-K75 is installed, the number of MIMO channels increases to 32.

Fading path (tap)

Each fading channel consists of up to 20 fading paths.

The figure 3-1 illustrates an example of single-channel fading with three transmission paths.

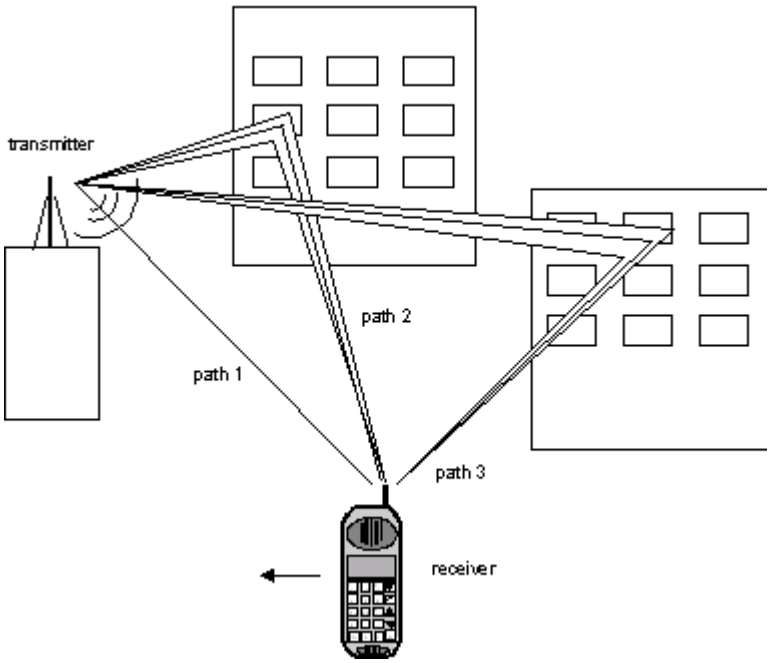


Fig. 3-1: Example of single-channel fading with three transmission paths (SISO configuration)

Path 1 = represents the discrete component, that is a direct line-of-sight (LOS) transmission between the transmitter and receiver (pure Doppler fading profile)
Paths 2 and 3 = represent the distributed components, that is signals which are scattered due to obstacles (Rayleigh fading profile)

Distributed components, like the paths 2 and 3, consists of several signal echoes and are referred to as "taps".

The figure 3-2 illustrates an example of two-channel fading with three transmission paths (taps) per channel.

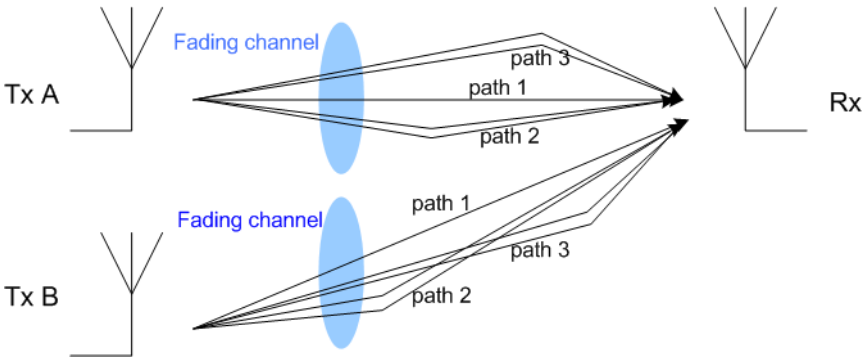


Fig. 3-2: Example of two-channel fading with three transmission paths each

The R&S SMW supports 20 fading paths per installed fading simulator.

Path group

In this implementation, a group of paths builds a "path group".

In the R&S SMW, the 20 fading paths are divided in 4 path groups. Each group consists of 3 fine delay and 2 standard delay paths.

Fading Profile

The fading profile determines which transmission path or which radio hop is simulated.

The following is a list of the basic fading profiles implemented in the Fading Simulator.

- **Static Path**
  A static path is an unfaded signal, that is a signal with constant amplitude and no Doppler shift; though this signal can undergo attenuation (loss) or delay.
- **Constant Phase**
  A suitable fading profile to simulate a reflection of an obstacle. Simulated is a transmission signal with constant amplitude and no Doppler shift, but with rotating phase.
- **Pure Doppler**
  A fading profile that simulates a direct transmission path on which Doppler shift is occurring due to movement of the receiver.
  See Path 1 on the figure 3-1.
- **Rayleigh**
  A suitable fading profile to simulate a radio hop which arises as a result of scatter caused by obstacles in the signal path, like buildings, etc.
  See also the conditions of the Paths 2 and 3 on the figure 3-1.
  The resulting received amplitude varies over time. The probability density function for the magnitude of the received amplitude is characterized by a Rayleigh distribution. This fading spectrum is "Classical".
- **Rice**
  A fading profile that simulates a Rayleigh radio hop along with a strong direct signal, i.e. applies a combination of distributed and discrete components (see figure 3-1).
  The probability density of the magnitude of the received amplitude is characterized by a Rice distribution. The fading spectrum of an unmodulated signal involves the superimposition of the classic Doppler spectrum (Rayleigh) with a discrete spectral line (pure Doppler).
  The ratio of the power of the two components (Rayleigh and pure Doppler) is configurable, see parameter Power Ratio.
  Example: The figure 3-3 shows a baseband signal with QPSK modulation and a rectangular filter which was subjected to Rician fading (one path). As a result of the luminescence setting on the oscilloscope, the variation in phase and amplitude of the constellation points caused by the fader is clearly visible.

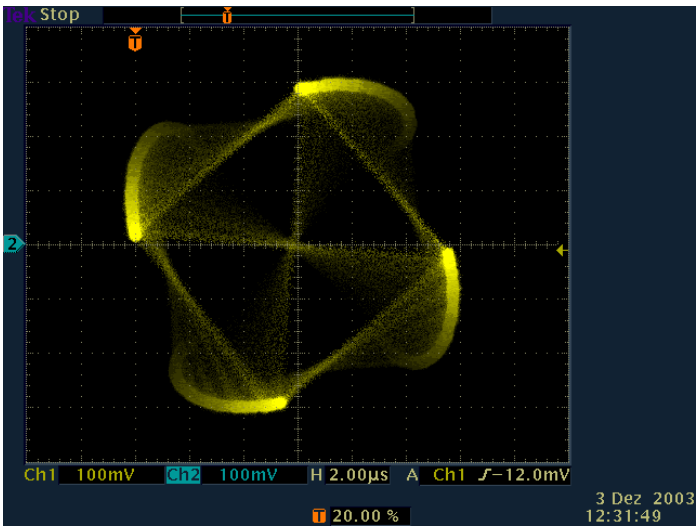


Fig. 3-3: Effect of a Rician fading on a baseband signal with QPSK modulation

MIMO correlation models

The R&S SMW supports the following ways to simulate spatial correlated MIMO channels:

- by description of transmit and receive correlation matrix with direct definition of matrix coefficients or based on the Kronecker assumption
- by definition of clusters at the transmitter and receiver side using channel parameter like angle spread, angle of arrival/departure (AoA/AoD), etc.

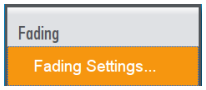
See chapter 6.3, "Fading Settings in MIMO Configuration", on page 87

3.4 Further Signal Processing

During further signal routing, you can additionally offset the faded signals or apply noise to them.

For more information, refer to sections "Adding Noise to the Signal" and "Impairing the Signal" in the R&S SMW User Manual.

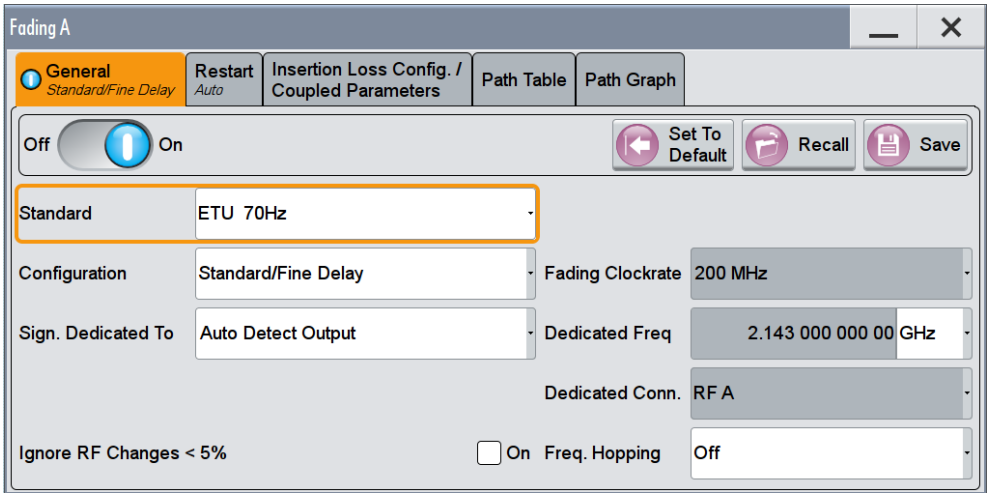
4 Fading Settings



The "Fading" dialog allows you to configure multipath fading signals. Regardless of the current "System Configuration > Mode", to access this dialog, proceed as follows:

► Select "Block Diagram > Fading > Fading Settings".

The "Fading" dialog opens and displays the general settings.



The dialog is divided into several tab, logically grouping the available setting.

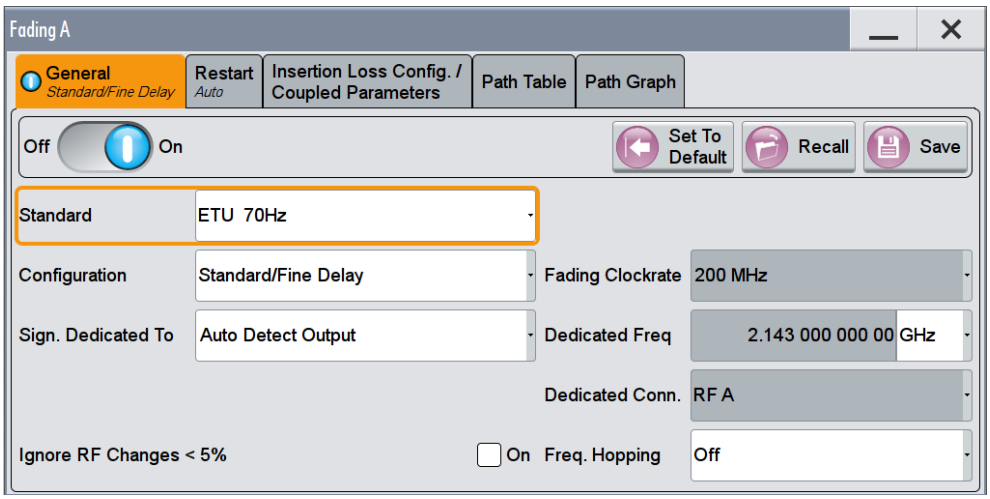
The remote commands required to define these settings are described in chapter 8, "Remote-Control Commands", on page 117.

The provided settings as well as related background information are described in:

- General Settings 25
- Restart Settings 34
- Insertion Loss Configuration, Coupled Parameters and Global Fader Coupling 35
- Path Table 40
- Path Graph 51
- Birth Death Propagation 52
- Moving Propagation 57
- Two Channel Interferer 65
- High Speed Train 71
- Custom Fading Profile 77

4.1 General Settings

► To access this dialog, select the "Fading > Fading Settings".



Apart from the standard "Set to Default" and "Save/Recall" functions, the dialog provides the settings to:

- In "System Configurations" with more than two entities, the dialog consists of more than one side tabs; one tab per entity. The tab name indicates the fader state the settings are related to.
  See also chapter 6.1, "Multiple Entity MxN MIMO Test Configurations", on page 85.
- Select a predefined fading profile according to the common mobile radio standards
- In instruments with RF output, activate and configure a frequency hopping.

State
Powers the fading simulator on or off.

When powered on, the fading process is initiated for the paths which are switched on.

A selectable trigger ("Restart Event") can be used to restart the fading process. The fading process always begins at a fixed starting point after each restart. This helps to achieve repeatable test conditions.

Remote command:
`[:SOURce<hw>]:FSIMulator[:STATe]` on page 135

Copy To / Entity
(requires option R&S SMW-K76)

In "System Configurations" with multiple entities, copies the settings of the current fading simulator to all or to the selected entities.

See also chapter 6.1, "Multiple Entity MxN MIMO Test Configurations", on page 85.

Remote command:
`[:SOURce<hw>]:FSIMulator:SISO:COPY` on page 120

Set to Default

Activates the default settings of the fading simulator.

By default, a path is activated with a Rayleigh profile and a slow speed. All of the other paths are switched off.

The following table provides an overview of the settings. The preset value is indicated for each parameter in the description of the remote-control commands.

Table 4-1: Default values

Parameter	Value
State	Off
Standard	User
Configuration	Standard Delay
Signal Dedicated to	RF Output
Speed Unit	km/h
Restart Event	Auto
Ignore RF Changes	Off
Frequency Hop. Mode	Off
Insertion Loss	
Insertion Loss Mode	Normal
Coupled Parameters	
All States	Off
Path Configuration	
State of path 1	On
State of all other paths	Off
Profile	Rayleigh
Delays	0
Speed of path 1	Slow
Speed of all other paths	0

Remote command:
`[:SOURce<hw>]:FSIMulator:PRESet` on page 124

Save/Recall

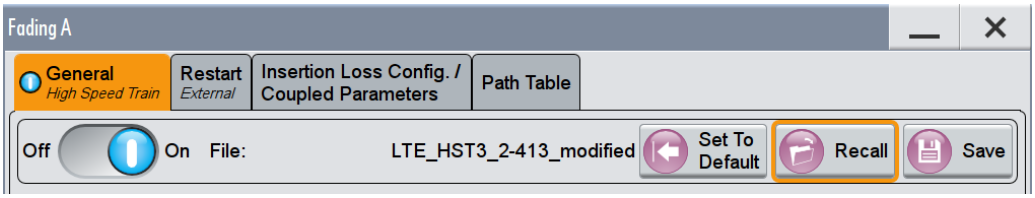
Accesses the "Save/Recall" dialog, i.e. the standard instrument function for storing and recalling the complete dialog related settings in a file. The provided navigation possibilities in the dialog are self-explanatory.

The file name and the directory it is stored in are user-definable; the file extension is however predefined.

See also, chapter "File and Data Management" in the R&S SMW User Manual.

The R&S SMW stores fading configurations in files with file extension `*.fad`.

The dialog displays the name of a currently loaded user settings file. The file name is displayed as long as you do not modify the settings.



Remote command:
[:SOURce]:FSIMulator:CATalog? on page 136
[:SOURce<hw>]:FSIMulator:LOAD on page 136
[:SOURce<hw>]:FSIMulator:STORe on page 137
[:SOURce]:FSIMulator:DELETE on page 137

Standard / Test Case
Selects predefined fading settings according to the test scenarios stipulated in the common mobile radio standards.

For an overview of the predefined standards along with the underlying test scenarios and the enabled settings, see chapter A, "Predefined Fading Settings", on page 188.

If one of the predefined parameters is modified, "User" is displayed. "User" is also the default setting.

Remote command:
[:SOURce<hw>]:FSIMulator:STANdard on page 129
[:SOURce<hw>]:FSIMulator:STANdard:REFerence on page 135

Configuration
Selects the fading configuration.

Note: The dynamic fading configurations "Birth Death Propagation", and "2 Channel Interferer" are disabled in MIMO configurations.

Depending on which configuration is selected, the further settings the "Fading" dialog change, particularly the path table.

Note: A separate path table is associated with each configuration, i.e. each time you select a new configuration, the instrument changes not only the bandwidth but loads a completely new path table.
Each changing in the configuration interrupts the fading process and restarts the calculation. If the instrument is fitted with more than one fading simulators, they are all affected.

"Standard/Fine Delay"

In the "Standard/Fine Delay" configuration, each group consists of five paths, 3 fine delay and 2 standard delay paths. This means that 20 paths can be simulated for a fading channel.

The standard and fine delay configurations differ in terms of the resolution of the path-specific delay:

- The resolution of the additional delay of a standard pat is 5 ns.
- The resolution of the additional delay of a fine delay pat is 2.5 ps.

The "Standard/Fine Delay" configuration is sufficient for classical fading with simulation of the level fluctuations. A delay configuration with the provided characteristics occur in the received signal as a result of a typical multipath propagation and the propagation conditions, which vary depending on the location and timing.

"Birth Death Propagation"

In the "Birth Death Propagation" configuration, the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP, 25.104-320, annex B4. Two paths are simulated which appear ("Birth") or disappear ("Death") in alternation at arbitrary points in time (see chapter 4.6, "Birth Death Propagation", on page 52).

"Moving Propagation"

In the "Moving Propagation" configuration and number of "Moving Channels" set to "One", the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP TS25.104, annex B3. Two paths are simulated: Path 1 has fixed delay, while the delay of path 2 varies slowly in a sinusoidal fashion.
Two additional predefined moving propagation scenarios according to the 3GPP TS36.141, annex B.4 can configured the "ETU200Hz Moving" and the "Pure Doppler Moving". To configure one of this scenarios for 3GPP or LTE, select the corresponding item under "Standard > 3GPP or LTE > Moving Propagation".

Note: The moving propagation conditions enabled by selecting the "Standard > 3GPP or LTE > Moving Propagation > Ref. + Mov. Channels" are identical to the conditions configured by enabling of "Moving Propagation Configuration" and number of "Moving Channels" set to "One".

See chapter 4.7, "Moving Propagation", on page 57 for more information.

"2 Channel Interferer"

In the "2 Channel Interferer" configuration, the fading simulator simulates test case 5 and 6 from MediaFlo.
Two paths are simulated: Path 1 has fixed delay, while the delay of path 2 varies slowly in a sinusoidal fashion or appears or disappears in alternation at arbitrary points in time (hopping).
See chapter 4.8, "Two Channel Interferer", on page 65 for more information.

"High Speed Train"

In the High Speed Train configuration, the fading simulator simulates propagation conditions in conformity with the test case 3GPP 25.141, annex D.4A and 3GPP 36.141, annex B.3.
The instrument simulates all the three scenarios as defined in the test specification. Additionally, user-defined HST conditions can be configured by selecting different profile and setting up the speed and the initial distances.
See chapter 4.9, "High Speed Train", on page 71 for more information.

"User Dynamic"

The "User Dynamic" configuration is provided for future use.

Remote command:
`[:SOURce<hw>]:FSIMulator:CONFiguration` on page 119
`[:SOURce<hw>]:FSIMulator:BIRThdeath:STATe` on page 143
`[:SOURce<hw>]:FSIMulator:MDELay:STATe` on page 162
`[:SOURce<hw>]:FSIMulator:TCINterferer[:STATe]` on page 183
`[:SOURce<hw>]:FSIMulator:HSTRain:STATe` on page 157

Moving Channels
This parameter determines whether only one or several moving channels are simulated.

"One" In this mode the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP TS25.104, annex B3.

"All" Per default, one moving channel with Rayleigh distribution and one tap is simulated.
Additional taps and paths can be enabled and configured in the "Path Table".

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:CHANnel:MODE` on page 158

Fading Clock Rate
Displays the clock rate used by the fading simulator for the signal processing.

The value depends on the selected "System Configuration" and influences the bandwidth of the generated signal.

Remote command:
`[:SOURce<hw>]:FSIMulator:CLOCk:RATE?` on page 121

Signal Dedicated To
Defines the frequency to that the signal of the whole Fader block is dedicated.

Example: How the R&S SMW determines the frequency used for the calculation of the Doppler Shift

This example shows how the R&S SMW determines the fader frequency in "Signal Dedicated To > Auto Detect Output" mode.

- In the "System Configuration > Fading/Baseband Config" dialog, enable a 2x2x2 MIMO configuration with "Baseband Sources > Coupled per Entity".
- In the "I/Q Stream Mapper":
  – route "Stream A/B > RF A/B", "Stream A/D und > BBMM 2" and "Stream B/C > BBMM 1" ("Combination > Add")
  – enable a "Frequency Offset = 5 MHz" for Stream D
- Connect an R&S®SGT100A to the BBMM**2** connector of the R&S SMW.
  In the "External RF and IQ" dialog, configure this connection and set the frequency of the connected instrument, e.g. "RF Frequency = 1.950 GHz".
- In the Status Bar, set "Freq A = 2.143 GHz"

The settings of your instrument should resemble the example on figure 4-1.

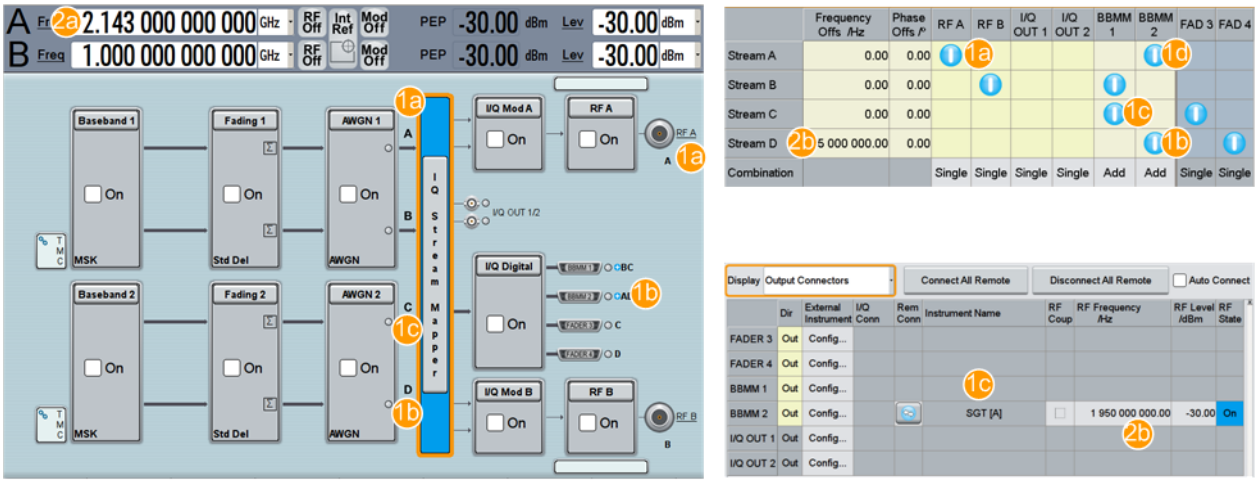


Fig. 4-1: Settings influencing the calculation of the Doppler Shift

1a, 1d = Routing of Stream A ("master" for "Fading 1")
1b = Routing of Stream D ("master" stream for "Fading 2" but not for "Fading 1")
1c = Routing of Stream C; an external device is not connected
2a = Frequency RF A, i.e. the frequency of Stream A
2b = Parameters influencing the frequency of Stream D

In this configuration, Stream A is the "master" stream for the "Fading 1"; Stream D is the "master" for "Fading 2", because of the connected external device.

Note that:

- although Stream C is first stream of "Fading 2" it is not the "master" one, because there is no external device connected to the BBMM1 or to the FAD3 connector.
- although an external device is connected to BBMM2, it is not the "master" for the "Fading 1", because the streams are evaluated "left to right" and "up to down".

Observe the values of the parameter "Dedicated Frequency" for Fader 1 and Fader 2. The settings of your instrument should resemble the example on figure 4-2.

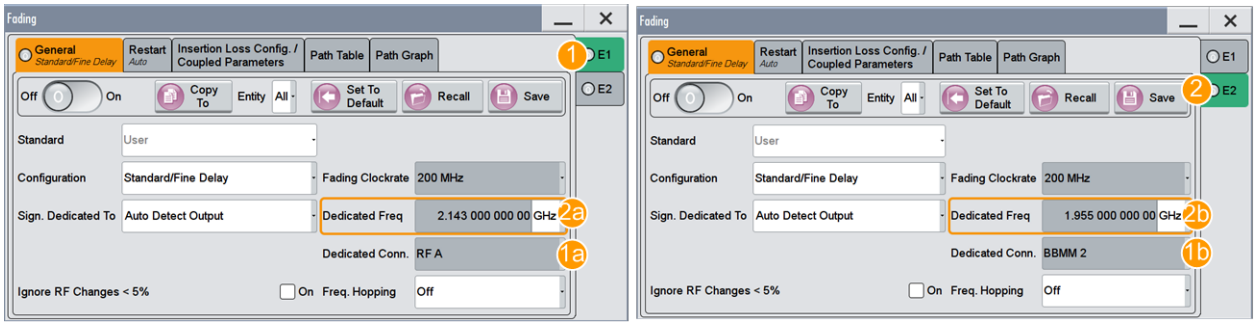


Fig. 4-2: "Dedicated Frequency" and "Dedicated Connector": understanding the displayed information

1 = Fader 1
2 = Fader 2
1a = "Dedicated Connector = RF A" because Stream A ("master") is routed to RF A
1b = "Dedicated Connector = BBMM 2" because Stream D is routed to BBMM 2 and an external instrument is connected to this interface
2a = "Dedicated Frequency = Freq A = 2.143 GHz"
2b = "Dedicated Frequency = RF Frequency$_{\text{External RF instrument}}$ + Frequency Offset = 1.95 GHz + 5 MHz = 1.955 GHz"

"Auto Detect Output"

The Doppler shift is calculated based on the actual RF frequency, that is *dynamically detected* depending on:

- the current signal routing in the "Stream Mapper", in particular the routing and the enabled "Frequency Offset" of the first ("master") stream of each "Fader"
  Note: The RF frequencies and the "Frequency Offset" of all other streams are ignored.
- the external instrument connected to the output interface the "master" stream is routed to
  ("System Configuration > External RF and I/Q")
- the "RF Frequency" of the connected instrument
  ("System Configuration > External RF and I/Q")

The R&S SMW continuously monitors these parameters, calculates the frequency and displays:

- the Dedicated Frequency
- the Dedicated Connector

A warning message informs you if the detection fails; the "Dedicated Frequency" is set to 1 GHz.

"Baseband Output"

Sets the fader frequency *manually*. The Doppler shift is calculated based on a select "Virtual RF" frequency.
If you use an external I/Q modulator to upconvert the generated faded baseband signal, set the value of the parameter Virtual RF to the modulation frequency of the external I/Q modulator.

Remote command:
`[:SOURce<hw>]:FSIMulator:SDEStination` on page 128

Dedicated Frequency
In Signal Dedicated To > "Auto Detect Output" mode, displays the dedicated RF frequency (incl. enabled "Frequency Offset" in the "I/Q Stream Mapper"), used for the calculation of the Doppler Shift.

A warning message informs you if the estimation fails; the "Dedicated Frequency" is set to 1 GHz.

See also:
- example "How the R&S SMW determines the frequency used for the calculation of the Doppler Shift" on page 30
- Dedicated Connector.

Note: The "Dedicated Frequency" cannot be updated if the RF frequency varies very fast, for example if a "RF Frequency Sweep" or a "List Mode" is active and the parameter Ignore RF Changes < 5PCT is disabled.
For more details, see the data sheet.

Remote command:
`[:SOURce<hw>]:FSIMulator:FREQuency` on page 121

Dedicated Connector
In Signal Dedicated To > "Auto Detect Output" mode, displays the connector used to determine the Dedicated Frequency.

See example "How the R&S SMW determines the frequency used for the calculation of the Doppler Shift" on page 30.

Remote command:
`[:SOURce<hw>]:FSIMulator:FREQuency:DETect?` on page 128

Virtual RF
In Signal Dedicated To > "Baseband Output" mode, sets manually the frequency used for the calculation of the Doppler shift.

This parameter is useful if:
- a user-defined Fader frequency is required
- an external I/Q modulator is used to upconvert the generated faded baseband signal.

Remote command:
`[:SOURce<hw>]:FSIMulator:FREQuency` on page 121

Ignore RF Changes < 5PCT
(instruments with RF output only)

Selects whether variation in the RF frequency (also in the frequency of connected external devices) that are smaller than 5% are to be ignored or not for the fading.

"On" Enables faster frequency hopping because small frequency changes (which can occur e.g. in GSM hopping) do not result in a short-term switch-off of the fader and a restart of the fading process.

Remote command:
`[:SOURce<hw>]:FSIMulator:IGNore:RFCHanges` on page 122

Freq. Hopping Mode
Activates frequency hopping and determines the behavior of the fading simulator after a frequency hop.

In real-world receivers, one of the reasons for frequency hopping could be that due to a change in the location of the receiver, the original carrier is no longer accessible.

In the fading simulator, frequency hopping is implemented by switching of the carrier frequency. The fading simulator is temporarily deactivated until the variation in the RF frequency is completed. The fading process starts then again at the new frequency.

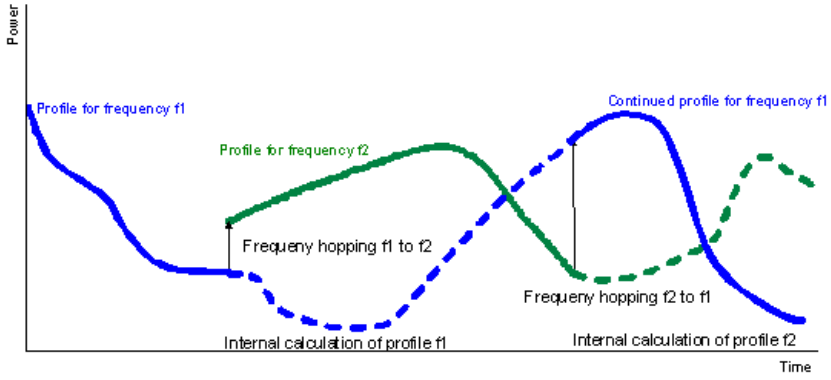
The instrument provides two modes for frequency hopping, that mainly differ in terms of the behavior when hopping back to a prior frequency.

Prior to activating frequency hopping, list mode must be activated in the "List Mode" dialog (State On). The target frequencies of the hops are determined by the frequency values in the selected list. The time until the next frequency hop is determined by the entered "Dwell Time". The HOP signal which marks the time point of the frequency hop can be output on one of the USER connectors. This settings are available only for the delay configurations.

For detailed information, refer to sections "Varying the RF Signal in List or Sweep Mode" and "Local and Global Connectors" in the R&S SMW user manual.

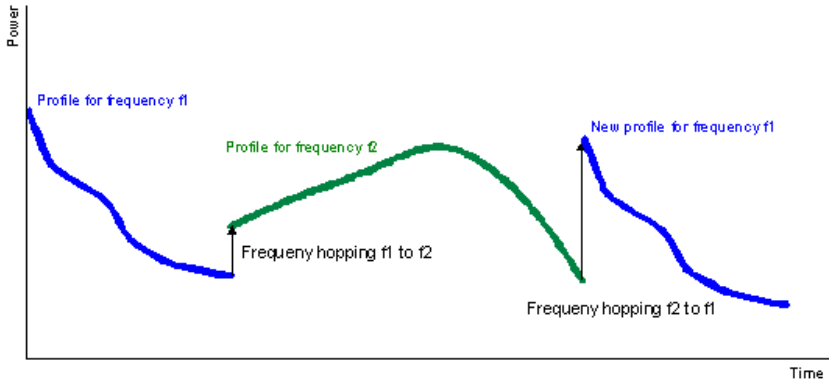
"Off" Frequency hopping is deactivated.

"In Band" Frequency hopping is activated. After hopping back to a previous hop frequency, the random process of the fading simulator is resumed as if the fading had continued also at this frequency, i.e. the process is not restarted.



The instrument simulates a situation in which the conditions after a return frequency hop have not changed substantially, i.e. the receiving conditions are the same as those from before the frequency hop. An example of a real-word situation is a pedestrian with a receiver that has moved only a few meters.
In this mode, the number of target hop frequencies and frequency hops is limited to four because the random processes for all of the prior hop frequencies are computed in parallel.

"Out Of Band" Frequency hopping is activated. The random process of the fader is restarted after a hop back to a previous target hop frequency and is thus not correlated with the random process which was underway prior to the frequency hop to this frequency.

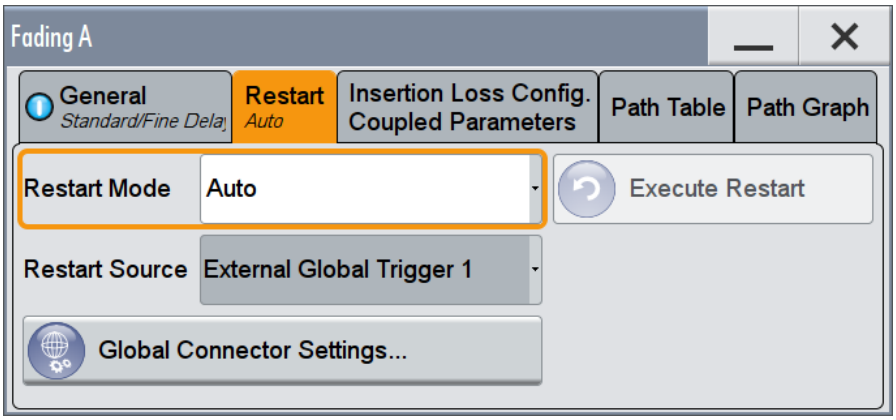


In this mode, the number of target frequencies and frequency hops is unlimited since the random process is computed only on the current frequency.

Remote command:
`[:SOURce<hw>]:FSIMulator:HOPPing:MODE` on page 122

4.2 Restart Settings

► To access this dialog, select "Fading > Restart".



Restart Mode
Selects the event which leads to a restart of the fading.

To achieve repeatable test conditions, after each restart the fading process starts at a fixed starting point. The fading process then passes through identical random processes for a particular setting.

"Auto" The modulation signal is continually faded.

"Manual, External" Not supported in the current version.

Remote command:
[:SOURce<hw>]:FSIMulator:RESTart:MODE on page 124

Execute Restart
Not supported in the current version.

Restart Source
Not supported in the current version.

Global Connector Settings
Provide a quick access to the related local and global connector settings.

For information, refer to the description R&S SMW User Manual, section "Local and Global Connectors".

4.3 Insertion Loss Configuration, Coupled Parameters and Global Fader Coupling

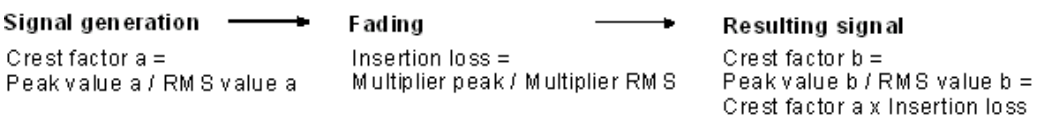
The fading process increases the crest factor of the signal, and this increase must be considered in the drive at the baseband level. Especially when multiple paths are superimposed or in case of statistical influences on a path, an insertion loss is required to provide a drive reserve. If the full drive level is reached nevertheless, the I/Q signals are limited to the maximum available level (clipping).

This section describes the setting, provided to control of the insertion loss and to simplify the operation in dual-channel fading.

Impact of the Fading Simulator on the Crest Factor of the Signal

The crest factor is a figure that measures the difference in level between the peak envelope power (PEP) and average power value (RMS) in dB. Hence, either increasing the peak value or decreasing the RMS value results in a higher crest factor. In this implementation, the instrument keeps the peak value as close as possible to the full drive level (multiplier peak > 1) but the fading simulator reduces the RMS value by the additional crest factor due to fading (multiplier RMS < 1). The ratio of these two multipliers is a value, known as the *insertion loss*.

The instrument derives the crest factor of the signal at the output of the fading simulator based on the crest factor of the signal at the input of the "Fading" block and the insertion loss.


Signal generation
Crest factor a =
Peak value a / RMS value a
Fading
Insertion loss =
Multiplier peak / Multiplier RMS
Resulting signal
Crest factor b =
Peak value b / RMS value b =
Crest factor a x Insertion loss

Overview of the provided modes and the main differences between them

In the R&S SMW, the used insertion loss is not a fixed value but is dynamically adjusted for different measurement tasks. For any of the predefined standards/test cases, the instrument selects an optimal range for the insertion loss. In a user-defined fading configuration, you define the way the range for insertion loss is determined.

From the following available modes, select the one most fitting to your application:

- "Normal"
  In this mode, the instrument calculates the required insertion loss value in a way, that a full drive is permitted, i.e the signal is not clipped at the maximum level.
  The mode results in a very high signal quality, but the RMS level is lower than the maximum possible level. Adjacent channel power (ACP) measurements, however, require a higher dynamic range and a lower insertion loss.
- "Low ACP"
  In this mode, the instrument outputs the signal with a higher level relative to the maximum drive, i.e. greater S/N ratio. However, this mode decreases the signal quality because of a higher percentage of clipping.
  It is recommended that you enable this mode only for fading paths with Rayleigh profile, as only this profile ensures a statistical distribution of level fluctuation. The other fading profiles are characterized by a non-statistical level fluctuations and a "Low ACP" mode leads to an enormous increase of clipping.
  Irrespectively of the selected fading profile, you still can and have to monitor the percentage of clipped samples.
- "User"
  This mode relays on a manually defined value. Depending on you particular application, you can find a favorable insertion loss configuration with the desired signal dynamic range and acceptable clipping rate.

Regardless of the selected mode and the path loss settings, the instrument adjust the insertion loss within this range to keep the output power constant. However, the maximum available output power of the R&S SMW is reduced by up to 18 dB.

Prerequisites for correct insertion loss adaptation

For correct automatic adaptation of the insertion loss, the processes involved in the fading simulation, i.e. the paths among themselves as well as the paths relative to the input signal, have to be *statistically independent* of each other. If statistically correlated processes occur, such as the fading of modulation signals with symbol rates approximating the delay differences of the fading paths, correct automatic adaptation of the insertion loss is not possible. A correlation requires, that you measure the level again and manually corrected it, e.g. by enabling of a suitable level offset.

The following are two examples explaining the possible reasons for correlation.

Example: Correlated processes resulting from the used modulation signal and the selected fading configuration

The instrument is configured to generate a QPSK signal with a symbol rate of 1 Msymb/s is generated and the PRBS 9 sequence as the data source.

Enabled is a fading configuration, consisting of two paths with a Rayleigh profile, identical speed and a resulting delay of 0 us and 1 us, respectively.

The symbol rates of the modulation signal are in the range of the delay differences of the fading paths; the autocorrelation of the modulation data (PRBS 9) to the adjacent symbol is not equal to 0. The fading process is therefore statistically not independent of the process of generating the modulation signal. The automatic calculation of the insertion loss is not correct.

Example: Correlated processes within the fading simulator

Enabled is a fading configuration, consisting of two paths with a pure Doppler profile and a resulting Doppler shift of 100 Hz. The start phases of the two paths differ.

This causes super impositions, which in the worst case (e.g. with a phase setting of 0° and 180°) may lead to the deletion of the signal; automatic calculation of the insertion loss is not possible.

The related settings are summarized in dialog "Fading > Insertion Loss Config/Coupled Parameters > Insertion Loss Configuration", see chapter 4.3.1, "Insertion Loss Configuration Settings", on page 37.

Coupling Fading Parameters

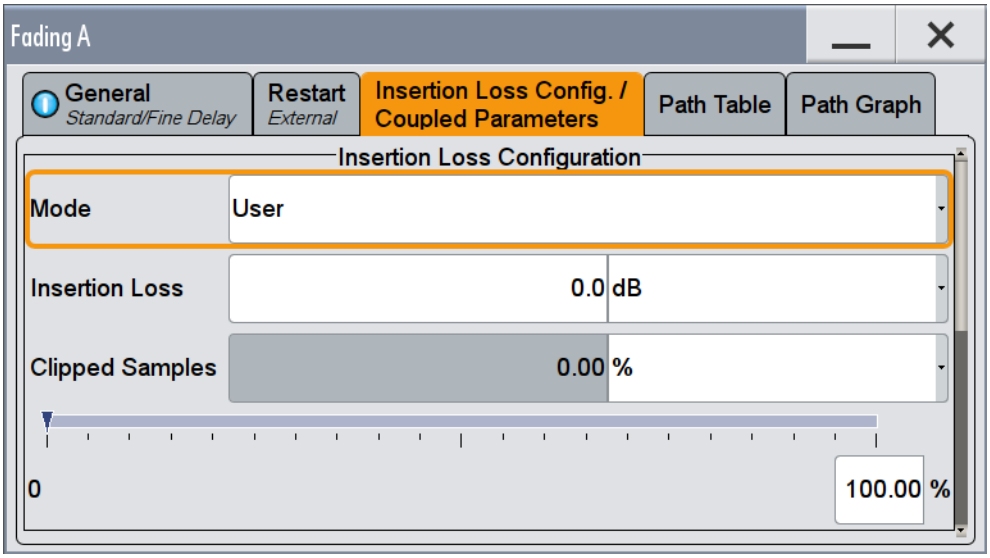
In standard mode ("System Configuration > Mode > Standard"), you can couple certain parameters and adjust them jointly. With enabled coupling, the setting of one of the Fading blocks are transferred to the second fading simulator. A subsequent change in the settings of one of the fading simulators results in settings adaptation in the other.

Logically, coupled parameters are available in instruments equipped with more than one Fading Simulator (i.e. more than one R&S SMW-B14 options).

The related settings are summarized in dialog "Fading > Insertion Loss Config/Coupled Parameters > Coupled Parameters", see chapter 4.3.2, "Coupled Parameters and Global Fader Coupling Settings", on page 39.

4.3.1 Insertion Loss Configuration Settings

► To access the dialog for defining the insertion loss, select "Fading > Insertion Loss Config/Coupled Parameters".



Insertion Loss Mode
Sets the mode for determining the insertion loss.

"Mode Normal" The insertion loss for a path of the fading simulator is automatically chosen so that even when lognormal fading is switched on, overdrive will occur only very rarely in the fading simulator. This setting is recommended for bit error rate tests (BERTs). The current insertion loss is displayed under "Insertion Loss".

"Mode Low ACP"
The insertion loss is automatically chosen so that an overdrive will occur with an acceptable probability. "Low ACP" mode is only recommended for fading paths with Rayleigh profile as only in this case statistical distribution of level fluctuation is ensured. For other fading profiles, non-statistical level fluctuations occur which lead to an enormous increase of clipping. However, monitoring the percentage of clipped samples is recommended for Rayleigh paths also.
The current insertion loss is displayed under "Insertion Loss".

"Mode User" Any value for the minimum insertion loss in the range from 0 dB to 18 dB can be selected. Desired value is entered under "Insertion Loss". This mode is provided to ensure optimization of the dynamic range and signal quality for any application. Display of the clipping rate for any value which is entered enables estimation of the signal quality for the specified signal dynamic range.

Remote command:
`[:SOURce<hw>]:FSIMulator:ILOSs:MODE` on page 123

Insertion Loss
Displays the current insertion loss in the "Normal" and "Low ACP" modes.

Entry of the insertion loss in "User" mode.

Remote command:
`[:SOURce<hw>]:FSIMulator:ILOSs[:LOSS]` on page 123

Clipped Samples
Displays the samples whose level is clipped as a %.

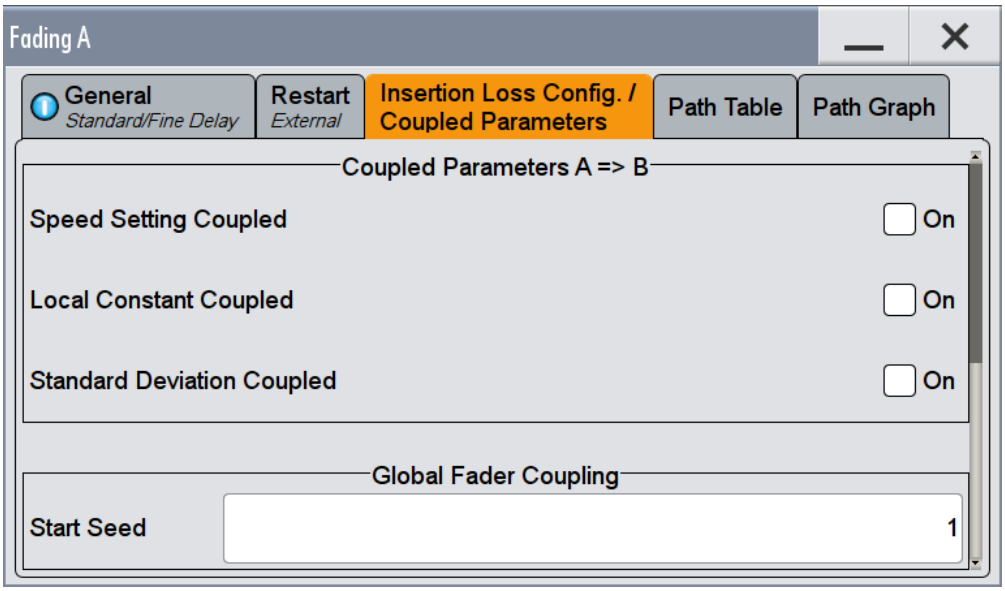
If the full drive level is reached for an insertion loss which is too low, the I/Q signals are limited to the maximum available level (clipping).

Remote command:
`[:SOURce<hw>]:FSIMulator:ILOSs:CSAMples?` on page 123

0 ... 100 %
Graphically displays the samples whose level is clipped as a %. The scale resolution is determined by entering the maximum value as a %.

4.3.2 Coupled Parameters and Global Fader Coupling Settings

► To access the dialog, select "Fading > Insertion Loss Config/Coupled Parameters".



Coupled Parameters
(available in "System Configuration > Mode > Standard")

Speed Setting Coupled ← Coupled Parameters
Sets the speed of the paths for both faders. The parameter Common Speed For All Paths is also coupled.

Remote command:
`[:SOURce<hw>]:FSIMulator:COUPle:SPEed` on page 138

Local Constant Coupled ← Coupled Parameters
With lognormal fading, the parameter Local Constant is coupled for the paths of both faders.

Remote command:
`[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:LCONstant` on page 137

Standard Deviation Coupled ← Coupled Parameters
With lognormal fading, the parameter Standard Deviation is coupled for the paths of both faders.

Remote command:
`[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:CSTD` on page 137

Start Seed
Enters the start seed for random processes inside the fading simulator. The autocorrelation of different seeds is more than seven days apart. This value is global for the instrument. If two instruments run with the same seed, fading processes will be identical after a retrigger of the fading simulator.

While working in MIMO mode that requires two instruments, set the start seeds of the instruments to different values.

Remote command:
`[:SOURce<hw>]:FSIMulator:GLOBal:SEED` on page 121

4.4 Path Table

The settings for configuration of the fading paths are grouped in a path table.

1. To access this dialog, select "Fading > Fading Settings > Path Table".

   The path table comprises the individual path and group parameters.

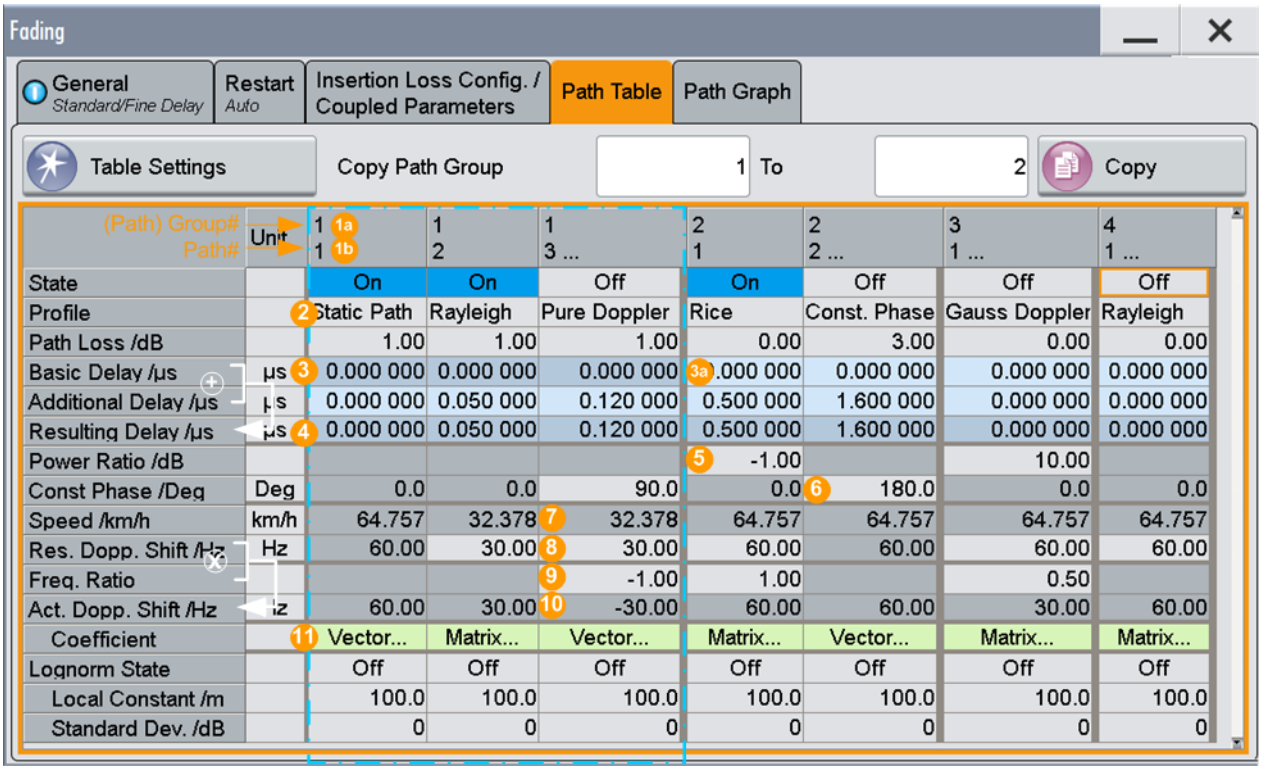


Fig. 4-3: Fading Path Table: Understanding the displayed information

1a/1b = Path group number (displayed in the first row) and path number (second row in the table header); the example shows 4 groups with different number of active paths (the first group is marked with a blue border)
2 = Fading profile, assigned per fading path
3/3a = Common group delay of a path group ("Basic Delay" is always 0 for group 1); adjustable for the other groups (light grey background)
4 = Resulting delay per path, calculated as the sum of the common group delay and the path-specific delay
5 = Adjustable parameter for paths with Rice, WM Rice of Gauss Doppler fading
6 = Adjustable parameter for paths with Pure Doppler and constant Phase fading
7 = For moving receivers, selected speed v or calculated as a function of the resulting Doppler shift f_D
8 = Set resulting Doppler shift f_D or calculated as $f_D=f_{RF}*v/c$, where f_{RF} is the selected RF and c the speed of light
9 = Frequency ratio cosφt is ratio of the actual Doppler shift f_A and the resulting Doppler shift f_D
10 = Actual Doppler shift f_A calculated as $f_A=f_D*\cos\varphi t$
10 = Pure display parameters are on a dark background
11 = Access to a "Vector" or a "MIMO Matrix" for configuration of the correlation between the channels

2. To display all five paths per each group, change the settings as follow:
   a) Select "Table Settings".
   b) In the "Path Table Settings" dialog, select "Path Filter > All Paths".

Cross-reference between the fading parameters

Consider the following interdependencies:

- Delay parameters

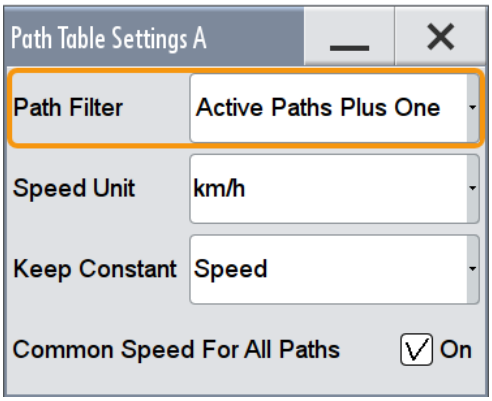
Resulting Delay = Basic Delay + Additional Delay

- Parameters influencing the Doppler shift calculation:
  Resulting Doppler Shift f_D calculated as:
  $f_D = (v/c)*f_{RF}$, where:
  – v is the Speed of the moving receiver
  – f_{RF} is the frequency of the RF output signal or the Virtual RF
  – $c=2.998*10^8$m/s is the speed of light

  For "Fading Profile > Pure Doppler, Gauss Doppler or Rice", the Actual Doppler Shift f_A calculated as:
  $f_A = f_D*\cos\varphi t$, where:
  – $\cos\varphi t$ is the Frequency Ratio and φ is the angle of incidence
  – f_D is the Resulting Doppler Shift

4.4.1 Table Settings

► To access this dialog, select "Fading > Fading Settings > Path Table > Table Settings".



The provided functions facilitate settings configuration and navigation in the path table, like suppression of the indication of disabled paths, quick change of the speed unit, etc.

Path Filter
Suppresses the indication of the disabled paths.

Remote command:
`n.a.`

Speed Unit
Toggles between the available units for speed. The value always remains unchanged but the display is automatically adapted to the selected unit.

Note: The remote control command changes only the units displayed in the graphical user interface. While configuring the speed via remote control, the speed units must be specified.

Remote command:
`[:SOURce<hw>]:FSIMulator:SPEed:UNIT` on page 129

Keep Constant
Selects whether to keep the speed or the resulting Doppler shift constant in case of frequency changes. If a constant speed is selected, the Doppler shift is calculated as function of the speed and the frequency and vice versa.

Remote command:
`[:SOURce<hw>]:FSIMulator:KCONstant` on page 124

Common Speed For All Paths
In delay configurations, activates/deactivates the same speed in all paths.

If Speed Setting Coupled is enabled, this parameter is also coupled in both faders.

"On" In this default state, a change of speed in a path automatically results in a change of speed in all of the other paths.

"Off" When switching from "Off" to "On", the speed entry for path 1 of group 1 is used for all of the paths.

Remote command:
`[:SOURce<hw>]:FSIMulator:CSPeed` on page 138

4.4.2 Copy Path Group Settings

The provided "Copy Path Group" settings enables you to copy the settings of one to a second fading group.

Copy Path Group
Selects a group whose settings are to be copied.

Remote command:
`[:SOURce<hw>]:FSIMulator:COPY:SOURce` on page 120

To
Selects a group whose setting is to be overwritten.

Remote command:
`[:SOURce<hw>]:FSIMulator:COPY:DESTination` on page 120

Copy
Triggers a copy procedure.

Remote command:
`[:SOURce<hw>]:FSIMulator:COPY:EXECute` on page 120

4.4.3 Path Table Settings

State Path
Activates a fading path.

After activating, the fading process is initiated for this path with the selected fading profile. However, the fading simulator must be switched on.

Remote command:
`[:SOURce<hw>]:FSIMulator[:STATe]` on page 135
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:STATe` on page 153
`[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:STATe` on page 153
`[:SOURce<hw>]:FSIMulator:HSTRain:PATH:STATe` on page 155

Profile
Determines the fading profile for the selected path. The fading profile determines which transmission path or which radio hop is simulated.

See also "Fading Profile" on page 22.

Depending on which profile is selected, certain parameters will be available in the path table and others will not be available.

With correlated paths, the profile setting must agree. When correlation is activated, the setting of the path for which correlation is switched on is accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

The fading profiles Gauss1, Gauss2, Gauss DAB, WiMAX Doppler and WiMAX Rice require the additional option R&S SMW-K72.

"Static Path"	Simulated is a static transmission path which can undergo attenuation (loss) or delay.
"Pure Doppler"	Simulated is a transmission path with an individual direct connection from the transmitter to the moving receiver (discrete component). The actual Doppler shift is determined by the Speed and Frequency Ratio parameters. **Tip:** In MIMO configuration, use the Relative Gain Vector Matrix Settings to configure beamforming.
"Rayleigh"	Simulated is a radio hop in which many highly scattered subwaves arrive at a moving receiver.
"Rice"	Simulated is a radio hop in which a strong direct wave (discrete component) arrives at a moving receiver in addition to many highly scattered subwaves. Use the parameter Power Ratio to set the ratio of the power of the two components (Rayleigh and pure Doppler).
"Const. Phase"	Simulated is one transmission path with the set constant phase rotation, attenuation (loss) or delay.

"Gauss1" Sum of two Gaussian functions and is used for excess delay times in the following range:
0.5 µs to 2 µs, (0.5 µs < τ_l < 2 µs).
$S(\tau_l,f) = G(A, -0.8f_d, 0.05f_d) + G(A_1, +0.4f_d, 0.1f_d)$
where A_1 is 10 dB below A.

"Gauss2" Sum of two Gaussian functions and is used for paths with delays in excess of 2 µs, (τ_l > 2 µs).
$S(\tau_l,f) = G(B, +0.7f_d, 0.1f_d) + G(B1, -0.4f_d, 0.15f_d)$
where B_1 is 15 dB below B.

"Gauss DAB" Composed of a Gaussian function and is used for special DAB profiles.
$S(\tau_l,f) = G(A, \pm 0.7f_d, 0.1f_d)$
where + $0.7f_d$ applies for even path numbers and $0.7f_d$ for odd, except path 1.

"Gauss Doppler"
Sum of a Gaussian function and a pure Doppler component.
$S(\tau_l,f) = G(0.1A; 0; 0.08f_d) + \delta(f-0.5f_d)$

"Gauss (0.08 fd)"
Composed of a Gaussian function with a standard deviation of $0.08*f_d$.
$S(\tau_l,f) = G(A; f; 0.08f_d)$

"Gauss (0.1 fd)"
Composed of a Gaussian function with a standard deviation of $0.1*f_d$.
$S(\tau_l,f) = G(A; f; 0.1f_d)$

"Gauss (Watters)"
Gauss (Watterson) fading profile.

"WM Doppler" The WiMAX Doppler fading profile is a rounded Doppler PSD model according to IEEE 802.16a.

"WM Rice" The WiMAX Rice fading profile is according to IEEE 802.16a.

"Bell Shape tgn Indoor/Bell Shape tgn Moving Vehicle"
Both Bell Shape fading profiles describe the indoor wireless channels according to IEEE 802.11n and IEEE 802.11ac.
The profiles are called after the resulting Doppler power spectrum that has a shape very similar to a "Bell". The second fading profile includes a Doppler component that represents a reflection from a moving vehicle.

"Custom" Customized Doppler fading profile developed by Cohda-Wirless; the profile describes the channels for testing of IEEE 802.11p signals.
To access the required settings, select "Custom", see chapter 4.10, "Custom Fading Profile", on page 77.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PROFile`
on page 151
`[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:PROFile`
on page 151

Path Loss
Enters the loss for the selected path.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOSS
on page 150

Basic Delay
Sets the Basic Delay.

Within a path group, all of the paths are jointly delayed by this value.

The path delay is calculates as:

Resulting Delay = Basic Delay + Additional Delay

The "Basic Delay" for group 1 is always 0. Thus, for the paths in group 1, the "Resulting Delay" is equal to the "Additional Delay".

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:BDELay
on page 144

Additional Delay
Sets the Additional Delay per path.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:ADELay
on page 144

Resulting Delay
Displays the Resulting Delay for the path.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:RDELay?
on page 152

Power Ratio
("Fading Profile > Rice, WM Rice, Gauss Doppler")

Enters the power ratio of the discrete component and distributed component.

The total power consisting of the two components is always constant. At a high power ratio, the discrete (Doppler) component prevails. At a low power ratio, the distributed (Rayleigh) component prevails.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PRATio
on page 150

Frequency Spread
("Fading Profile > Gauss Watterson")

Sets the frequency spread for the Gauss Watterson fading.

Remote command:
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FSPRead
on page 149

Frequency Shift
("Fading Profile > Gauss Watterson")

Enters the frequency shift for the Gauss Watterson fading.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FSHift`
on page 148

Const. Phase
Enters the phase by which the path is multiplied.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CPHase`
on page 146

Start Phase
("Fading Profile > Pure Doppler, WM Doppler")

A transmission path with the set start phase rotation is simulated which can undergo attenuation (loss) or delay.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CPHase`
on page 146

Speed
Enters the speed *v* of the moving receiver.

The Resulting Doppler Shift f_D is calculated as:

$f_D = (v/c)*f_{RF}$, where

f_{RF} is the frequency of the RF output signal or the virtual RF frequency and $c=2.998*10^8$m/s is the speed of light

Example:

If v = 100 km/h and f_{RF} = 1 GHz, the f_D = 92.66 Hz

Consider the following interdependencies:

- If the speed is changed, the resulting Doppler shift is automatically modified.
- If "Path Table Settings > Common Speed in All Paths > On", a change of speed in one path automatically results in a change of speed in all of the other paths of the fader.
- In the "Fading Profile > Pure Doppler/Rice/Gauss Doppler", the actual Doppler Shift f_A is a function of the selected speed v and also of the parameter Frequency Ratio.
  See also "Cross-reference between the fading parameters" on page 41
- In "System Configuration > Mode > Standard", you can couple the speed for the paths of both faders.
- With correlated paths, the speed setting must agree. When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in

which path it was made). The same applies to all paths of the two faders when coupling is activated.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:SPEed`
on page 152

Resulting Doppler Shift
If "Table Settings > Keep Constant > Speed", this parameter displays the resulting Doppler shift f_D.

The value depends on the selected:
- Speed
- RF frequency f_{RF} or the Virtual RF
- For "Fading Profile > Pure, Gauss Doppler or Rice", the "Actual Doppler Shift" depends also on the selected Frequency Ratio.

See "Cross-reference between the fading parameters" on page 41.

To set the Doppler shift, enable "Table Settings > Keep Constant > Resulting Doppler Shift". In this case, the "Speed" is calculated as a function of the selected "Resulting Doppler Shift" and the RF frequency f_{RF}.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler[:RESulting]`
on page 147

Frequency Ratio
("Fading Profile > Pure, Gauss Doppler or Rice")

Sets the ratio of the actual Doppler Shift f_A to the Resulting Doppler Shift f_D.

The actual Doppler shift is a function of the simulated angle of incidence of the discrete component (see figure 4-4) and is calculated as:

$f_A = f_D * \cos\varphi t$, where:

$\cos\varphi t$ is the "Frequency Ratio" and $f_D = (v/c) * f_{RF}$ is the Resulting Doppler Shift.

Negative values indicate a receiver that is going away from the transmitter, and positive values a receiver that is approaching the transmitter.

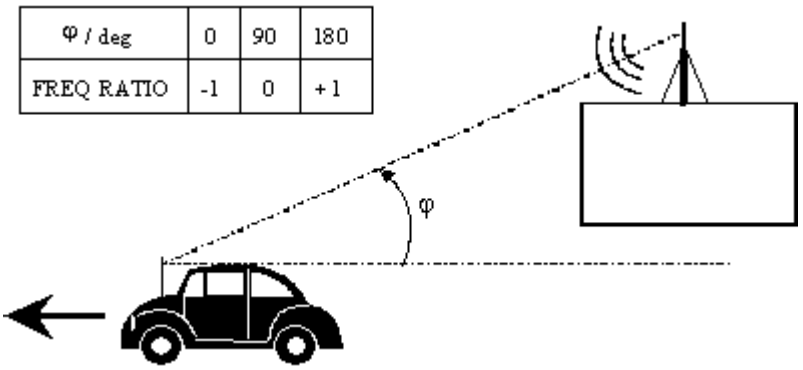


Fig. 4-4: Doppler shift as a function of the angle of incidence

See also "Cross-reference between the fading parameters" on page 41

With correlated paths, the speed setting of the Frequency Ratio must agree. When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FRATio` on page 148

Actual Doppler Shift
("Fading Profile > Pure Doppler, Gauss Doppler, Rice")

Displays the actual Doppler shift f_A. The value depends on Frequency Ratio and Resulting Doppler Shift.

See also "Cross-reference between the fading parameters" on page 41.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler:ACTual?` on page 147

Correlation Path
Switches on correlation to the corresponding path of the second fader for dual-channel fading.

Setting correlation necessitates synchronous signal processing on both channels. This means the settings of the following parameters for the correlated fading paths must agree:

- "Profile"
- "Speed"
- "Frequency Ratio"
- "Lognormal Parameters"
- "Resulting Doppler Shift"
- "Actual Doppler Shift"

When correlation is activated, the settings of the path for which correlation is switched on are accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Correlated paths in dual-channel fading with the same input signal simulate the receiving conditions experienced by a receiver having two antennas in which the received signals exhibit a certain degree of correlation due to a similar environment.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:STATe` on page 146

Correlation Coefficient
Sets the magnitude of the complex correlation coefficient as a percentage.

The higher the entered percentage, the greater the correlation of the statistical fading processes for the two correlated paths. Highly correlated ambient conditions for the signal are simulated in this manner.

Each fader has a maximum of 20 paths.

With correlated paths, the coefficient setting must agree. When correlation is activated, the setting of the path for which correlation is switched on is accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:COEFficient` on page 145

Correlation Coefficient Phase
Sets the phase of the complex correlation coefficient in degrees.

With correlated paths, the coefficient phase setting must agree. When correlation is activated, the setting of the path for which correlation is switched on is accepted for both paths. Afterwards, the most recent modification applies to both paths (no matter in which path it was made).

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:PHASe` on page 145

Lognormal State
Switches lognormal fading on/off (slow fading).

Simulated is an additional slow fluctuation of the received amplitude of a moving receiver. This can occur due to peculiarities in the landscape or topography (e.g. when driving through a depression). Lognormal fading has a multiplicative effect on the path loss. The multiplication factor is time-variable and logarithmically normally distributed. If a Rayleigh profile is set simultaneously, what we obtain is Suzuki fading.

Note: Since the slow level fluctuation is not taken into account statistically in the computation of the insertion loss, the output power can deviate from the displayed power.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:STATe` on page 150

Local Constant
Enters the Local Constant for lognormal fading.

The Local Constant L and the speed v of the moving receiver determine the limit frequency f_L for lognormal fading:

$f_L = v/L$.

The power density spectrum of an unmodulated carrier consists of a discrete spectral line at f_{RF} and a frequency-dependent continuous component for which the following applies:

$$S(f) = const * e^{-0.5*\left(\frac{f - f_{RF}}{f_L}\right)}$$

The lower setting limit is a function of the (virtual) RF frequency f_{RF} and is calculated as follows:

$L_{min} = 12*10^9 / f_{RF}$

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:LCONstant` on page 149

Standard Deviation
Enters the standard deviation in dB for lognormal fading.

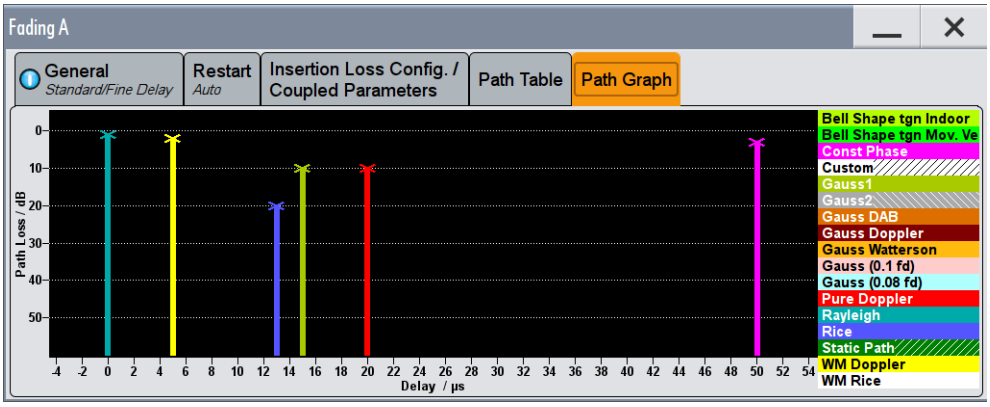
Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:CSTD` on page 149

4.5 Path Graph

To access the graphical representation of the configured path,

► select "Fading > Path Graph".

The path graph provides a quick overview of the paths as they are configured in the delay modes.



The signal delay is plotted on the x-axis. The minimum value is 0 s. The maximum value is equal to the maximum delay, determined by the sum of max. Basic Delay and max. Additional Delay. The relative path power is plotted on the y-axis, with 0 dB corresponding to the maximum power on the path (path loss = 0 dB).

Each path is represented by a bar. The color of the bar indicates the fading profile of the path. The color coding for the individual profiles is shown right next to the graphics. The "Path Loss" can be read off from the height of the bar. The minimum value is 0 dB, and the maximum value is – 50 dB.

4.6 Birth Death Propagation

In the "Birth Death Propagation" configuration, the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP, 25.104-xxx, annex B4. Here, the behavior of a receiver is tested when it is confronted with the sudden disappearance and reappearance of a signal. This can occur, for example, when a pedestrian making a call walks around the corner of a building.

Two paths are simulated which appear ("Birth") or disappear ("Death") in alternation at arbitrary points in time. The points in time fall within a grid of integer delays [-5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5] µs. After a certain time ("Hopping Dwell"), a path disappears from a given grid position and appears simultaneously at another randomly chosen grid position. During this hop, the second path remains stable at its grid position. After a further "Hopping Dwell" elapses, the second path changes its position. Now, the first path remains at its position and so on. The two paths never appear at the same time position at the same time (see figure 4-5).

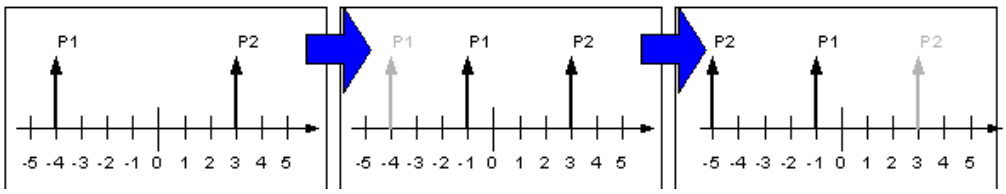


Fig. 4-5: Example of a sequence of hops in Birth Death Propagation

Since it is not possible to generate negative time values (delays), the actual hop range is from 0 to 10 µs.

According to annex B4, each path has the same loss and phase and no Doppler shift. The time until the position of a path is changed is also specified (see table 4-2).

Table 4-2: Default parameter values (Birth Death Propagation)

"Profile"	Pure Doppler
"Path Loss"	0 dB
"Min. Delay"	0 µs
"Delay Grid"	1 µs
"Positions"	11
"Max. Delay"	10 µs
"Hopping Dwell"	191 ms
"Speed"	0 m/s
"Frequency Ratio"	1.0

Path Graph

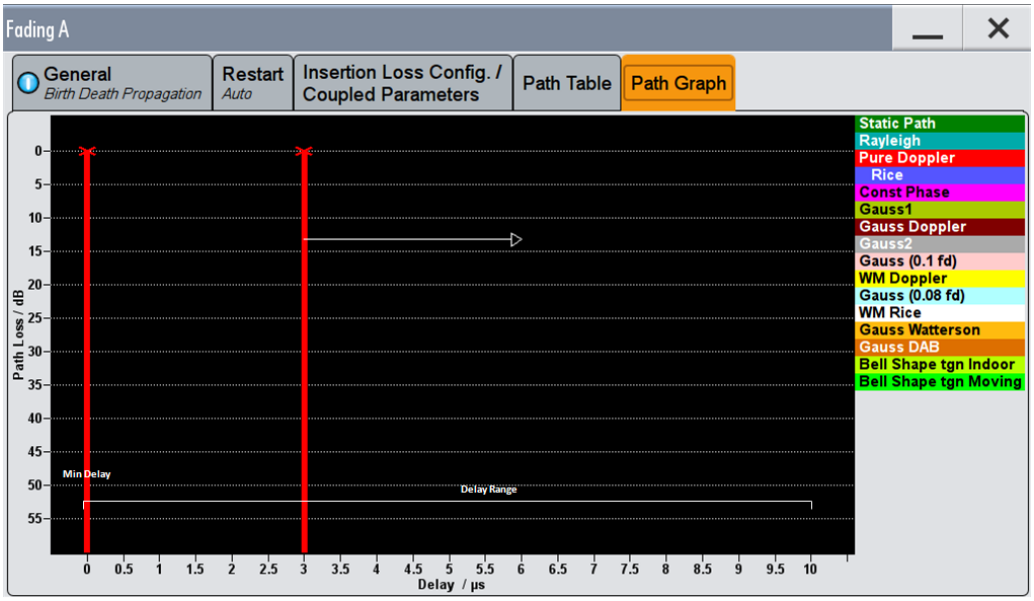
The graphical display of the fading paths in Birth Death Propagation mode shows as an example the changing positions of the two paths within the delay grid. The displayed position change does not correspond to the actual delay hops of the real signal. An arrow indicates the direction of the delay hop of the path that will next change its position, with the head of the arrow marking the new position.

The delay grid is plotted on the x-axis. The permissible delay range and the delay offset are shown in the graphics (see the "Min Delay" and the "Delay Range" indication on the graph). The path power is plotted on the y-axis, with 0 dB corresponding to the maximum power on the path (path loss = 0 dB). The scaling of the axes and the displayed path power match the real settings.

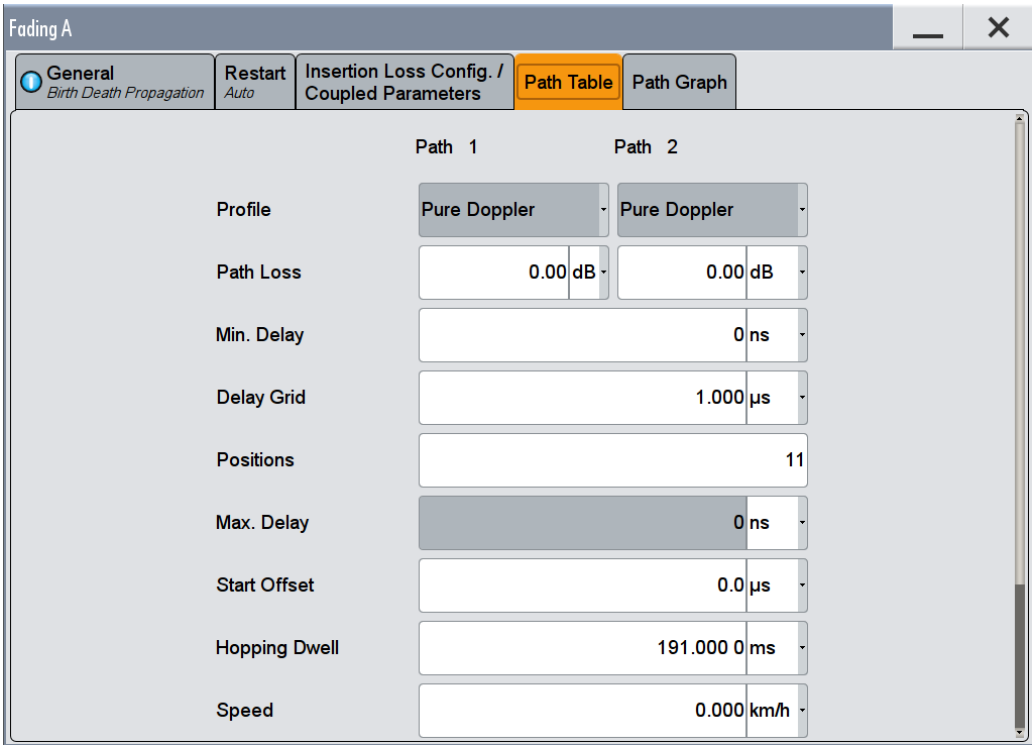
The scaling of the x-axis depends on the set delay range. It always starts at 0 µs and rages up to 40 µs at the most (= maximum for delay range). The minimum delay corresponds to the start value of the delay range. The maximum delay is defined by the minimum delay, the delay grid and the number of possible hop positions.

Max Delay = (Positions – 1) x Delay Grid + Min. Delay

The (mean) delay offset is calculated from the minimum and maximum delay ((max. delay - min. delay)/2).



The table 4-2 lists the default values for Birth Death Propagation. However, these parameters can also be set for further tests in the fading path table.



Profile
Displays the fading profile for birth death propagation. The fading profile has a fixed setting to "Pure Doppler".

A transmission path is simulated in which there is an individual direct connection from the transmitter to the moving receiver (discrete component). The Doppler frequency shift is determined by the "Speed" and "Frequency Ratio" parameters.

Remote command:
`[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:PROFile` on page 140

Path Loss
Enters the loss for the selected path.

Remote command:
`[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:LOSS` on page 140

Min Delay
Enters the minimum delay for the two fading paths.

The minimum delay corresponds to the start value of the delay range.

The delay range is defined by the minimum delay, the delay grid and the number of possible hop positions. It can be in the range between 0 and 40 us.

0 us < (Positions – 1) x Delay Grid + Min. Delay < 40 us

The scaling of the X-axis is adapted according to the entry (see "Path Graph" on page 53).

Invalid entries are rejected, the next possible value is entered.

Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:MINimum on page 139

Delay Grid
Enters the delay grid. The value defines the resolution for the possible hop positions of the two fading paths in the delay range.

The scaling of the X-axis is adapted according to the entry (see "Path Graph" on page 53).

Invalid entries are rejected, the next possible value is entered.

Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:GRID on page 139

Positions
Enters the number of possible hop positions in the delay range.

The scaling of the X-axis is adapted according to the entry (see "Path Graph" on page 53).

Invalid entries are rejected, the next possible value is entered.

Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:POSitions on page 141

Maximum Delay
Indication of the maximum delay. The maximum delay corresponds to the stop value of the delay range (see "Path Graph" on page 53).

The maximum delay is defined by the minimum delay, the delay grid and the number of possible hop positions.

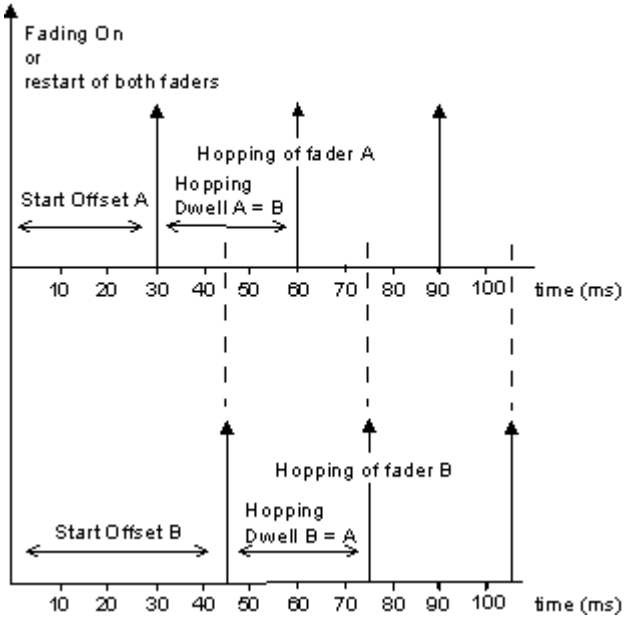
Max Delay = (Positions – 1) x Delay Grid + Min. Delay

Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:MAXimum? on page 139

Start Offset
Enters the timing offset by which the start of "Birth Death Propagation" is offset with respect to when fading is switched on or a restart as a result of a restart trigger.

This allows the user to precisely displace birth death events with respect to one another during two-channel fading. This is required in some 3GPP base station tests.

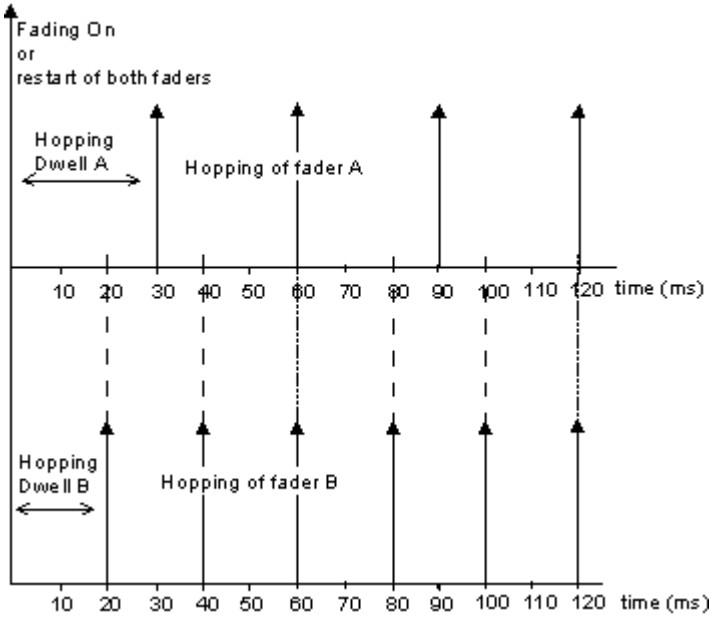
If the same hopping dwell time is entered in both faders, the offset will take place by a constant value.



Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:SOFFset on page 141

Hopping Dwell
Enters the time until the next change in the delay of a path (birth death event).

During two-channel fading, the dwell times of the two channels can be set independently. This causes the hop time points of the two channels to coincide repeatedly. This is a way of simulating tough receiving conditions as arise when two receiving channels simultaneously change frequency (see figure).



Remote command:
[:SOURce<hw>]:FSIMulator:BIRThdeath:HOPPing:DWELl on page 140

Speed
Enters the speed v of the moving receiver.

The resulting Doppler shift is dependent on the speed v and the entered ratio of the actual Doppler shift to the set Doppler shift f_D. This ratio is determined in the "Frequency Ratio" line. The resulting Doppler frequency can be read off from the "Res. Doppler Shift" line. It may not exceed the maximum Doppler frequency.

If the speed is changed, the resulting Doppler shift is automatically modified.

Remote command:
`[:SOURce<hw>]:FSIMulator:BIRThdeath:SPEed` on page 141

Resulting Doppler Shift
Displays the resulting Doppler shift.

Remote command:
`[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:FDOPpler?` on page 142

Frequency Ratio
Enters the ratio of the actual Doppler shift to the Doppler shift set with the "Speed" parameter.

Remote command:
`[:SOURce<hw>]:FSIMulator:BIRThdeath:FRATio` on page 142

Actual Doppler Shift
Displays the actual Doppler shift.

The actual Doppler frequency is determined by the selected "Speed" and "Frequency Ratio" (i.e. the ratio of the actual Doppler frequency to the resulting Doppler frequency).

Remote command:
`[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:FDOPpler:ACTual?` on page 143

4.7 Moving Propagation

In the "3GPP/LTE Moving Propagation" configuration, the fading simulator simulates dynamic propagation conditions in conformity with the test case 3GPP TS25.104, annex B3 or 3GPP TS36.141, annex B.4.

The fading simulator enables configuration according to three predefined moving scenarios. The first one represents moving conditions with one reference and one moving channel whereas in the other two all paths are moving.

The predefined scenarios are as follow:

- "Ref. + Mov. Channel" - Simulation of moving propagation conditions in accordance to the 3GPP TS25.104, annex B3.
  (see chapter 4.7.1, "Moving Propagation Conditions for Testing of Baseband Performance", on page 58)

- "ETU200Hz Moving" - Simulation of moving propagation conditions in accordance to the scenario 1 described in 3GPP TS36.141, annex B.4.
  (see chapter 4.7.2, "Moving Propagation Conditions for Testing the UL Timing Adjustment Performance", on page 60)
- "Pure Doppler Moving" - Simulation of moving propagation conditions in accordance to the scenario 2 described in 3GPP TS36.141, annex B.4.
  (see chapter 4.7.2, "Moving Propagation Conditions for Testing the UL Timing Adjustment Performance", on page 60)

It is also possible to adjust some of the parameters of these predefined scenarios and simulate user-definable moving propagation conditions.

4.7.1 Moving Propagation Conditions for Testing of Baseband Performance

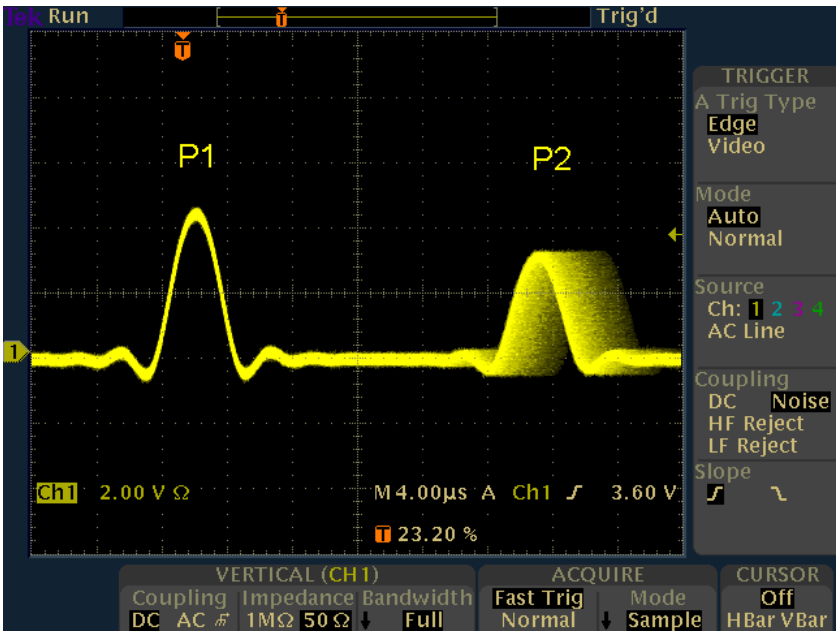
Simulating moving propagation conditions for testing of baseband performance

► To simulate moving propagation conditions for testing of baseband performance in accordance to the 3GPP TS25.104, annex B3:

a) select "Configuration > Moving Propagation" and "Moving Channels > One" or
b) select "Standard > 3GPP > Moving Propagation > Ref. + Mov. Channel".

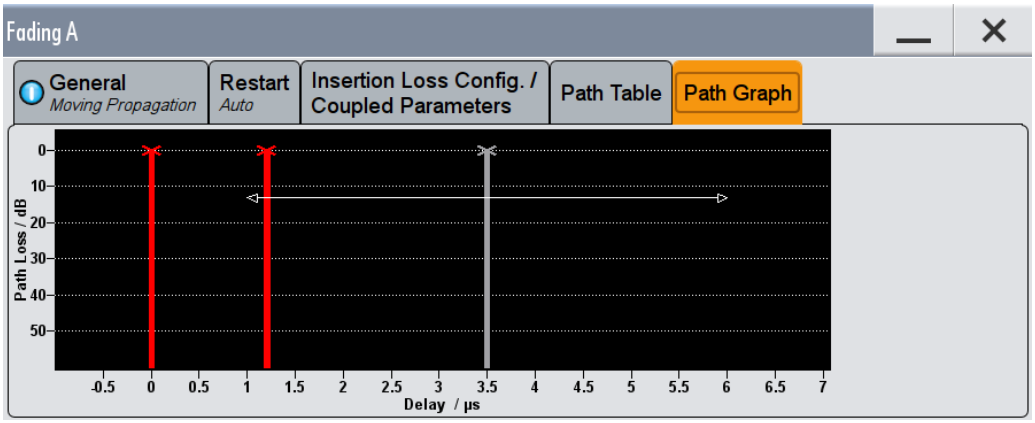
Here, the behavior of a receiver is tested in response to slow delay variations in a signal. Two paths are simulated: Path 1 has fixed delay (Reference Path, P1), while the delay of path 2 varies slowly in a sinusoidal fashion (Moving Path, P2). The two paths have no fading profile. They have the same level, the same phase and no Doppler shift.

The following figure illustrates a baseband signal with ASK modulation (only one 1 bit, then many 0 bits) which was subjected to moving propagation. Path P1 remains still while path P2 moves in time relative to it. As a result of the luminescence setting on the oscilloscope, the way in which P2 wanders over time is clearly visible.



The graphical display of the fading paths in Moving Propagation mode shows as an example the changing positions of the moving path with respect to the stationary reference path. The displayed position change does not correspond to the actual delay changes of the real signal.

The delay grid is plotted on the x-axis. The permissible delay range for the moving path is shown in the graphics by the horizontal arrow. The grey path indicates the set start delay for the Moving Path. The path power is plotted on the y-axis, with 0 dB corresponding to the maximum power on the path (path loss = 0 dB). The scaling of the axes and the displayed path power match the real settings.



The delay $\Delta\tau_{one}$ of the moving path obeys the following equation:

$$\Delta\tau_{one} = "Delay" + \frac{"Variation(Pk\,Pk)"}{2} * \sin\frac{2\pi t}{"VariationPeriod"}$$

Where the values relate to the values proposed in the test case 3GPP, 25.104xxx, annex B3 as follows:

- Variation (Peak-Peak) = A
- Delay = B + A/2
- Variation Period = 2π /Δ ω

The table 4-3 list the settings required to attain the values proposed in the test case 3GPP TS25.104, annex B3.

Table 4-3: Default parameter values (Moving Propagation)

Reference Path:	"Delay"	0 us
	"Path Loss"	0 dB
	"State"	On
Moving Path:	"Variation (Pk Pk)"	5 us
	"Variation Period"	157 s
	"Delay"	3.5 us
	"Path Loss"	0 dB
	"State"	On

These default values can be changed in the Path Table dialog.

4.7.2 Moving Propagation Conditions for Testing the UL Timing Adjustment Performance

The purpose of the uplink timing adjustments testing is to verify whether the base station sends timing advance commands and whether the base station estimates appropriate the uplink transmission timing.

Simulating moving propagation conditions

To simulate moving propagation conditions for testing the UL timing adjustment performance in conformity with the test cases "Moving propagation conditions", as defined in 3GPP 36.141, annex B.4:

► Select "Standard > LTE > Moving Propagation > ETU200Hz Moving or Pure Doppler Moving"

The figure 4-6 illustrates the moving propagation conditions for the test of the UL timing adjustment performance.

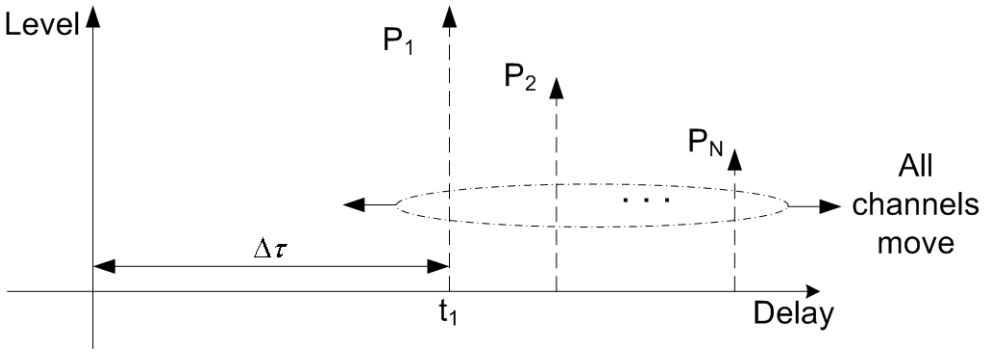


Fig. 4-6: Moving Propagation Conditions

Use the parameter "Additional Delay" to configure the relative timing among all paths. The time difference between the reference timing and the first path is according to the following equation:

$$\Delta\tau_{all} = \frac{"Variation(Pk\ Pk)"}{2} * \sin\frac{2\pi t}{"Variation\ Period"}$$

The 3GPP specification defines the uplink timing adjustments requirements for normal and extreme conditions. The following two scenarios for the testing of UL timing advance are specified:

- Scenario 1: ETU200 ("ETU200Hz Moving") is the scenario for testing in normal conditions.
  This scenario considers ETU channel model and UE speed of 120km/h.
- Scenario 2: AWGN ("Pure Doppler Moving") is the extreme conditions optional scenario.
  The scenario corresponds to AWGN channel model and UE speed of 350km/h.

The fading simulator generates the signals for these scenarios in according to the parameters defined in the 3GPP specification (see table table 4-4). However, the fading simulator also allows the re-configuration of some of the predefined values.

Table 4-4: Default parameter values

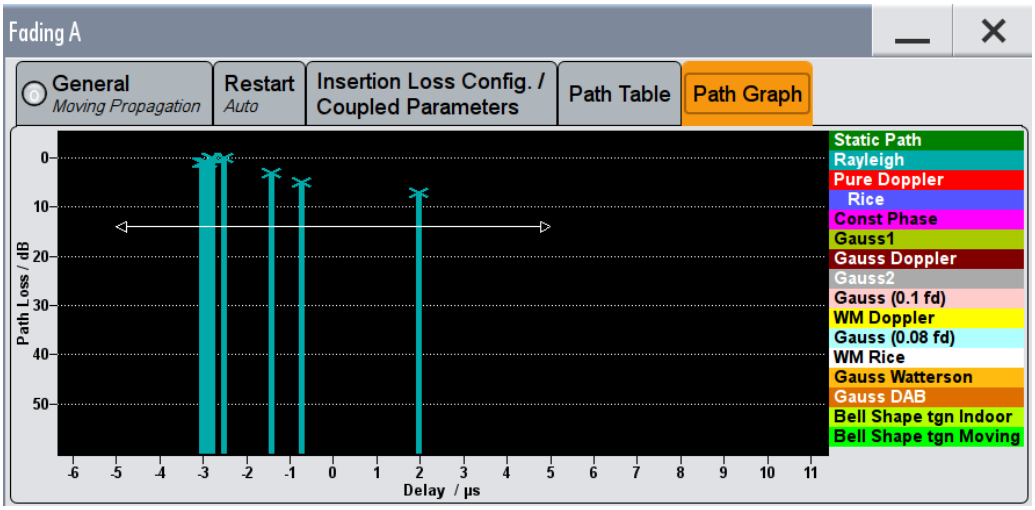
Parameter	Scenario 1	Scenario 2
Channel Model	ETU200Hz Moving	Pure Doppler
UE speed	120 km/h	350 km/h
CP length	Normal	Normal
"Variation (Peak-Peak)"	10 µs	10 µs
Δω	0.04 1/s	0.13 1/s
"Variation Period" = 2π/Δω	157.1 s	48.3 s

4.7.2.1 Scenario 1

Here, the behavior of a moving receiver is tested, i.e. the simulated scenario represents a moving receiver that changes its distance to the base station. The Fading Sim-

ulator generates the signal as a sequence of complete cycles of approach towards to the BS antenna and moving away from it.

Per default, three Rayleigh path groups with three paths each are simulated. All paths move.



The path group 1 has a fixed delay ("Basic Delay = 0 s"); the "Basic Delay" of the other two path groups can be configured. The relative timing among all paths is determined by the parameter "Additional Delay".

The three path groups have the same phase and speed; the Doppler shift is calculated as a function of the selected speed.

4.7.2.2 Scenario 2

One path without a fading profile (Pure Doppler) is simulated. The path has constant level and constant speed.

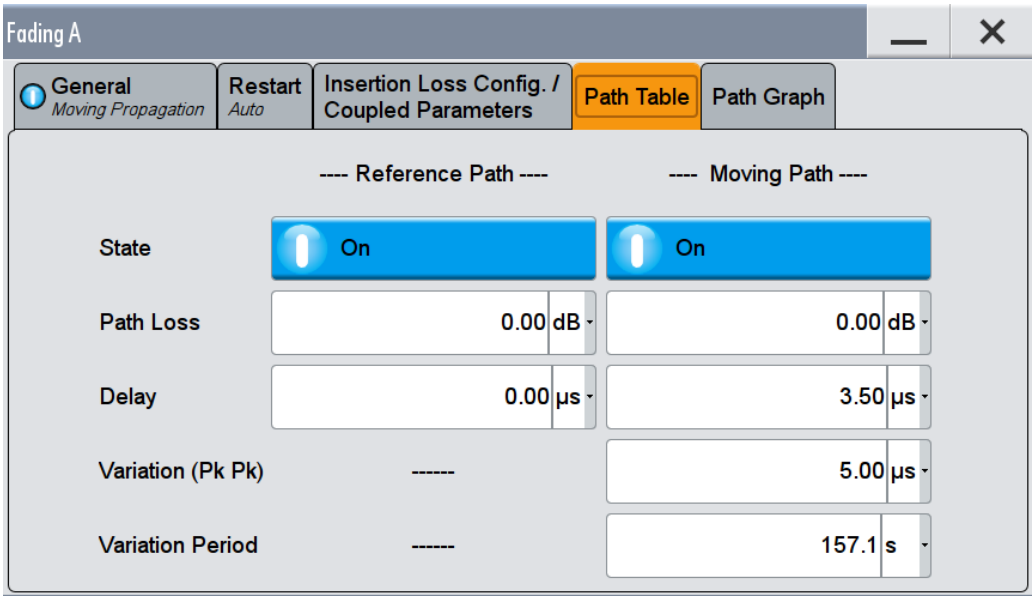
4.7.3 Path Tables Moving Propagation

The parameters available for configuration depend on the selected number of Moving Channels, one or all.

4.7.3.1 One Moving Channel

► To access the settings for configuring the moving and the reference path for the moving propagation with one moving channel, perform on of the following:

a) select "Fading > Standard > 3GPP > Ref. + Mov. Channel"
b) select "Fading > Configuration > Moving Propagation" and "Moving Channels > One".



Reference Path Settings
The following settings are provided:

State ← Reference Path Settings
Activates reference path P1 for moving propagation.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:REFerence:STATe` on page 161

Path Loss ← Reference Path Settings
Enters the loss for the reference path.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:REFerence:LOSS` on page 161

Delay ← Reference Path Settings
Enters the delay for the reference path.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:REFerence:DELay` on page 161

Moving Path Settings
The following settings are provided:

State ← Moving Path Settings
Activates moving fading path P2 for moving propagation.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:MOVing:STATe` on page 160

Path Loss ← Moving Path Settings
Enters the loss for the moving fading path.

Remote command:
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:LOSS on page 160

Delay ← Moving Path Settings
Enters the average delay for the moving fading path.

The delay of the moving path slowly varies sinusoidal within the set variation range around this delay.

Remote command:
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:DELay:MEAN on page 159

Variation (Peak-Peak) ← Moving Path Settings
Enters the range for the delay of the moving fading path for moving propagation. The delay of the moving path slowly varies sinusoidal within this range around the set mean delay.

Remote command:
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:DELay:VARiation on page 160

Variation Period ← Moving Path Settings
Period duration for delay variation. A complete variation cycle is passed through in this time.

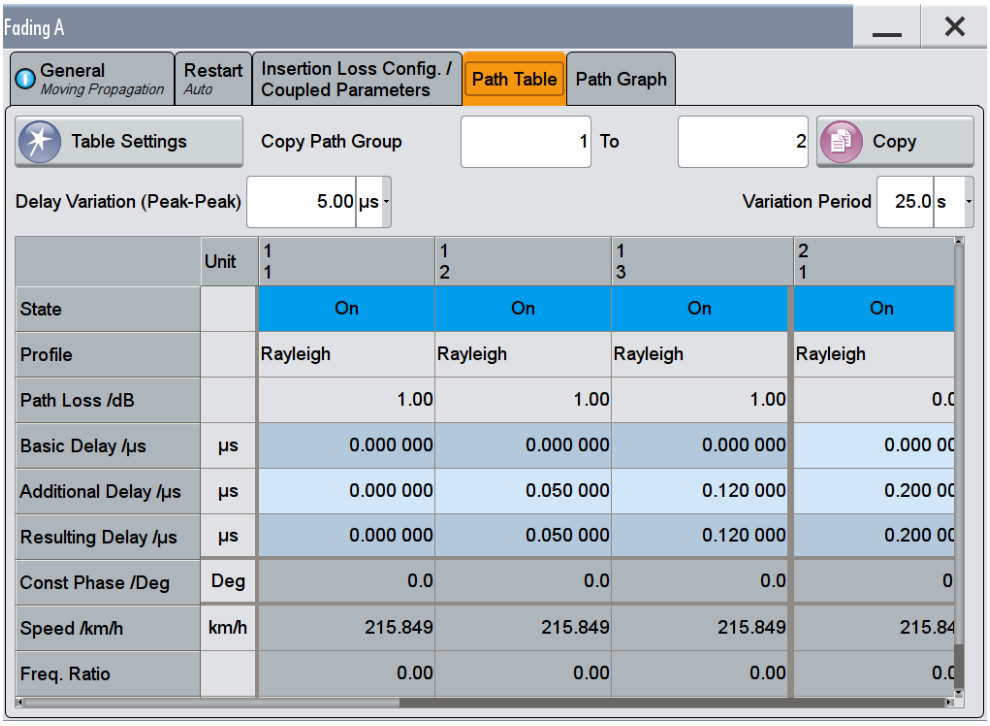
Remote command:
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:VPERiod on page 160

4.7.3.2 All Moving Channels

► To access the settings for configuring the moving path groups and their paths, perform one of the following:

a) select "Fading > Standard > LTE > Moving Propagation > ETU200Hz Moving"
b) select "Fading > Standard > LTE > Moving Propagation > Pure Doppler Moving"
c) select "Fading > Configuration > Moving Propagation" and "Moving Channels > All".

The number and the parameters of the predefined paths depend on the selected scenario.



The most parameters in the "Path Table" correspond to the parameters described in chapter 4.4, "Path Table", on page 40.

Delay Variation (Peak-Peak)
Enters the range for the delay of the moving fading paths for moving propagation with all moving channels. The delay of the moving path slowly varies sinusoidal within this range around the set mean delay.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:ALL:MOVing:DELay:VARiation`
on page 158

Variation Period
Period duration for delay variation. A complete variation cycle is passed through in this time.

Remote command:
`[:SOURce<hw>]:FSIMulator:MDELay:ALL:MOVing:VPERiod` on page 157

4.8 Two Channel Interferer

In the "2 Channel Interferer" configuration, the fading simulates dynamic propagation in conformity with the test cases 5 and 6 from MediaFlo. Here, path 1 has a fixed delay while the delay of path two either varies slowly in a sinusoidal way or appears in alternation at arbitrary points in time. Thus, 2 channel interferer fading can be considered as a combination of birth death propagation fading and moving propagation fading. The

main difference is the broader range of propagation obtainable with 2 channel interferer fading.

Each of the fading profiles "Static Path", "Pure Doppler" and "Rayleigh" can be allocated to the two paths.

Predefined Setting

The table 4-5 and table 4-6 list the settings required to attain the values proposed in the MediaFlo test case 5 and 6.

Table 4-5: Test Case 5

Reference Path:	"Profile"	Static Path
	"Relative Delay"	10 us
	"Average Power"	-3 dB
	"Fading Type"	Rayleigh, 60 km/h
	"Doppler Spectrum"	Classic 6 dB
	"Static Delay"	40 us
Moving Path:	"Profile"	Hopping
	"Relative Delay"	0/110 us
	"Average Power"	-3 dB
	"Fading Type"	Static
	"Doppler Spectrum"	N/A
	"Dwell Time"	2.9 s

Table 4-6: Test Case 6

Reference Path:	"Profile"	Static Path
	"Relative Delay"	100 us
	"Average Power"	-3 dB
	"Fading Type"	Static
	"Doppler Spectrum"	N/A
Moving Path:	"Profile"	Sliding
	"Relative Delay"	0/200 us
	"Average Power"	-3 dB
	Fading Type	Rayleigh, 3 km/h
	"Doppler Spectrum"	Classic 6 dB
	"Period"	160 s

How to use the provides settings and configure a 2 channel interfering signal

The following are two examples on how to configure a "2 Channel Interferer" conditions. See how to:

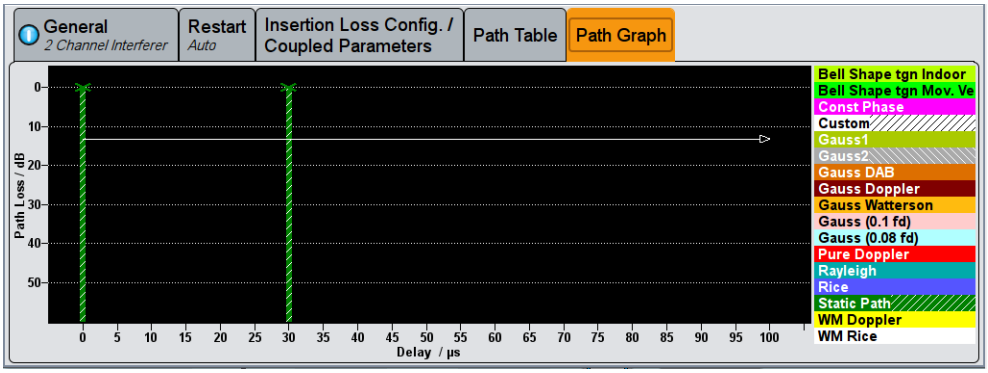
- "To enable a hopped moving mode" on page 67
- "To enable a sliding moving mode" on page 67

To enable a hopped moving mode

Enable a 2 channel interfering signal with the following settings:

1. Reference Path:
   a) "Delay Min = 30 µs"
   b) "Profile = Static Path"
   c) "Path Loss = 0 dB"
2. Moving Path:
   a) "Delay Min = 0 µs"
   b) "Profile = Static Path"
   c) "Path Loss = 0 dB"
   d) "Delay Max = 100 µs"
   e) "Moving Mode > Hopping"
3. Enable "Reference Path > State > On" and "Moving Path > State > On"
4. Open the "Fading > Path Graph" view.

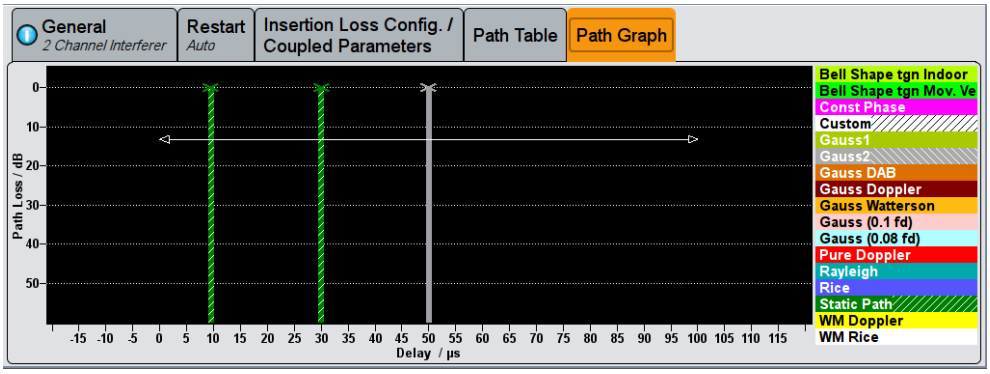
   The following figure shows the resulting path graph.



To enable a sliding moving mode

1. Use the settings of "To enable a hopped moving mode" on page 67.
2. Change the "Moving Mode > Sliding".

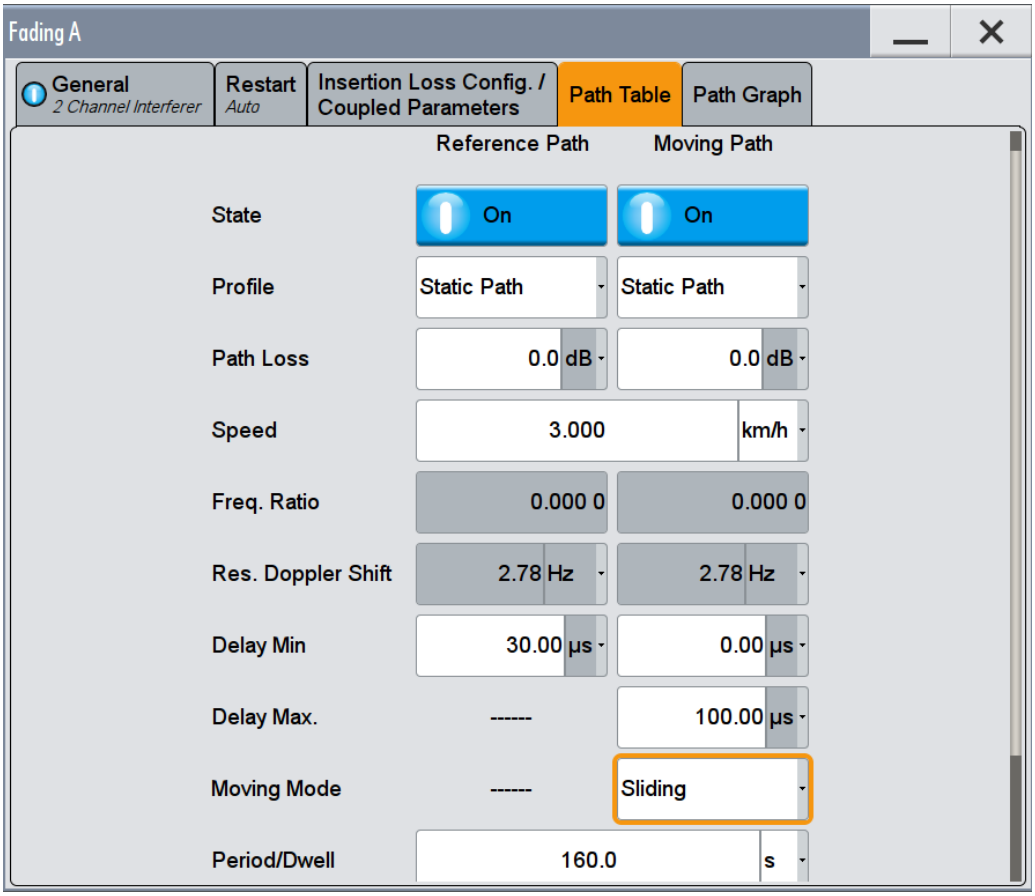
3. Open the "Fading > Path Graph" view.



The moving path slides from the minimum delay (30 us) to the maximum delay (100 us) and back. The grey bar indicates the mean delay of the moving path. The horizontal arrow indicates the permissible delay range for the moving path.
The displayed position change does not correspond to the actual delay changes of the real signal.

2 Channel Interferer Settings

The table 4-5 and table 4-6 list the default values for "2 Channel Interferer" configuration. You can use these default values and/or adjust the provided settings in the fading path table.



State
Activates/deactivates either the reference path or the moving path for 2 channel interferer fading.

Remote command:
`[:SOURce<hw>]:FSIMulator:TCINterferer[:STATe]` on page 183
`[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:STATe` on page 186

Profile
Selects the fading profile either for the reference path or the moving path to be used for 2 channel interferer fading.

Remote command:
`[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FDOPpler?` on page 185

Path Loss
Sets the attenuation of either the reference path or moving path to be used for 2 channel interferer fading.

Remote command:
`[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:LOSS` on page 185

Speed
(Rayleigh only)

Enters the speed v of the moving receiver. The unit for entering the speed under "Speed Unit" can be chosen in the upper section of the menu.

The resulting Doppler shift is dependent on the speed v and the entered ratio of the actual Doppler shift to the set Doppler shift f_D. This ratio is determined in the "Frequency Ratio" line. The resulting Doppler frequency can be read off from the "Res. Doppler Shift" line. It may not exceed the maximum Doppler frequency.

If the speed is changed, the resulting Doppler shift is automatically modified.

Remote command:
`[:SOURce<hw>]:FSIMulator:TCINterferer:SPEed` on page 184

Freq. Ratio
Enters the ratio of the actual Doppler shift to the Doppler shift set with the "Speed" parameter.

Remote command:
`[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FRATio`
on page 185

Res. Doppler Shift
Displays the actual Doppler shift.

The actual Doppler frequency is determined by the entered "Speed" and the entered ratio of the actual Doppler frequency to the set Doppler frequency ("Frequency Ratio").

Remote command:
`[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FDOPpler?`
on page 185

Delay Min
Enters the minimum delay for either the reference path or the moving path.

The minimum delay of the moving path corresponds to the start value of the delay range.

The delay range is defined by the minimum delay and the maximum delay.

The scaling of the x-axis is adapted according to the entry.

Invalid entries are rejected, the next possible value is entered.

Remote command:
`[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:DELay:MINimum` on page 184

Delay Max (Moving Path)
Enters the maximum delay for the moving path.

The maximum delay of the moving path corresponds to the end value of the delay range.

The delay range is defined by the minimum delay and the maximum delay.

The scaling of the x-axis is adapted according to the entry.

Invalid entries are rejected, the next possible value is entered.

Remote command:
[:SOURce<hw>]:FSIMulator:TCINterferer:MOVing:DELay:MAXimum on page 183

Moving Mode (Moving Path)
Selects the Type of moving applied to the moving path.

"Sliding" The reference path has a fix delay while the delay of the moving path varies slowly in a sinusoidal way.

"Hopping" The reference path has a fix delay while the delay of the moving path appears or disappears in alternation at arbitrary points in time.

Remote command:
[:SOURce<hw>]:FSIMulator:TCINterferer:MOVing:MMODe on page 183

Period/Dwell
Enters either the dwell time or the period of a complete cycle for the moving path depending on the selected Moving Mode (Moving Path).

"Moving Mode"	"Period Dwell"
"Sliding"	sets the period for a complete cycle of the moving path
"Hopping"	sets the dwell time of the moving path

The gradient of the delay/period ratio may not fall below 6µs/s, that is, the minimum value of the period depends on the value of the delay.

If the value for the delay is increased in a way that the value for the gradient falls below 6µs/s, the value for the period is recalculated automatically.

Example:

"Delay Min" = 20 us, "Delay Max" = 120 us, "Moving Mode = Sliding"

[("Delay max" - "Delay min")/2]*2π)/"Period/Dwell" = 6

"Period/Dwell" = 314/6 = 52.36 s

The value cannot be decreased below this value.

Remote command:
[:SOURce<hw>]:FSIMulator:TCINterferer:PERiod on page 184

4.9 High Speed Train

In the "High Speed Train" configuration, the fading simulator simulates propagation conditions in conformity with the test case "High speed train conditions", as defined in 3GPP 25.141, annex D.4A and 3GPP 36.141, annex B.3. Here, the behavior of a receiver in high speed train conditions is tested, i.e. the simulated scenario represents a very fast moving receiver that drives past an antenna. The fading simulator gener-

ates the signal as a sequence of complete cycles of approach towards to the BS antenna and departure from it.

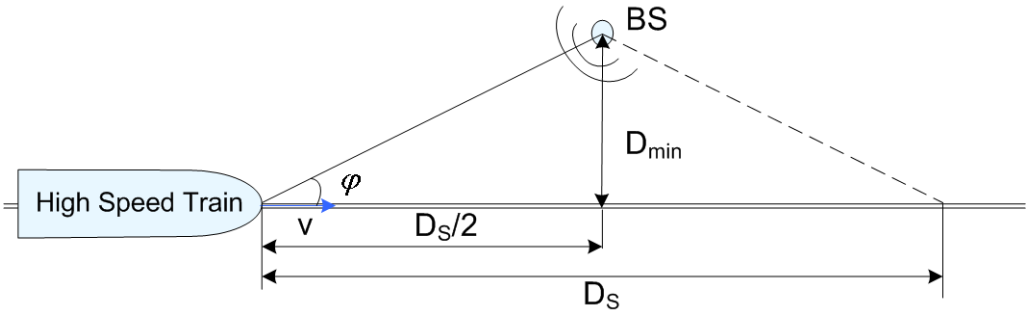


Fig. 4-7: High Speed Train Propagation

Three high speed scenarios are defined:

- Scenario 1: Open Space
- Scenario 2: Tunnel with leaky cable
- Scenario 3: Tunnel for multi-antennas

4.9.1 Scenario 1 and Scenario 3

For each of the scenarios 1 and 3, one path without a fading profile is simulated (Pure Doppler). The path has constant level, no delay and variable Doppler shift.

The Doppler shift for these scenarios is calculated as follow:

$$f_A(t) = f_D \cos\varphi(t)$$

where $f_A(t)$ is the actial Doppler shift and f_D is the maximum Doppler frequency.

The cosine of angle is given by:

$$\cos\varphi(t) = \frac{D_s/2 - vt}{\sqrt{D_{\min}{}^2 + (D_s/2 - vt)^2}}, \quad 0 \le t \le D_s/v$$

where:

- $D_S/2$ is the distance in meters between the train and the BS at the beginning of the simulation
- D_{min} is the minimum distance in meters between the BS and the railway track
- v is the velocity of the train in m/s
- t is time in seconds

For scenario 1 and for BS with receiver diversity, the Doppler shift variation is the same between the antennas.

4.9.2 Scenario 2

Scenario 2 is not defined for EUTRA/LTE test cases.

For scenario 2, one Rician fading propagation channel with Rician factor K=10 dB and with one tap is simulated. The Rician factor *K* is defined as the ratio between the dominant signal power and the variant of the other weaker signals (see "K (Rician factor)" on page 77).

4.9.3 High Speed Train Scenario Parameters

The table 4-7 gives an overview of the parameters of the HST test scenarios according to the test case "High speed train conditions".

Table 4-7: Parameters for high speed train conditions

Parameter	Value		
	Scenario 1	**Scenario 2**	**Scenario 3**
D_S	1000 m	Infinity	300 m
D_{min}	50 m	-	2 m
K	-	10 dB	-
v	350 km/h	300 km/h	300 km/h
f_D	1340 Hz	1150 Hz	1150 Hz

The figure 4-8 and figure 4-9 show the trajectory of the Doppler shift for scenario 1 and 3 for the test parameters specified in the test case. For these two scenarios, the Doppler Shift trajectories for any user-defined parameters are also displayed in the "3GPP HST" dialog.

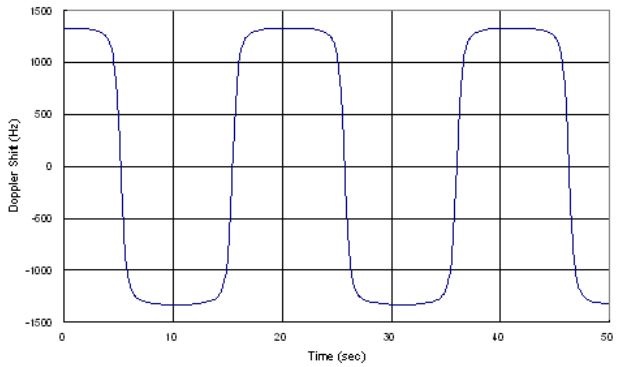


Fig. 4-8: Doppler shift trajectory for scenario 1

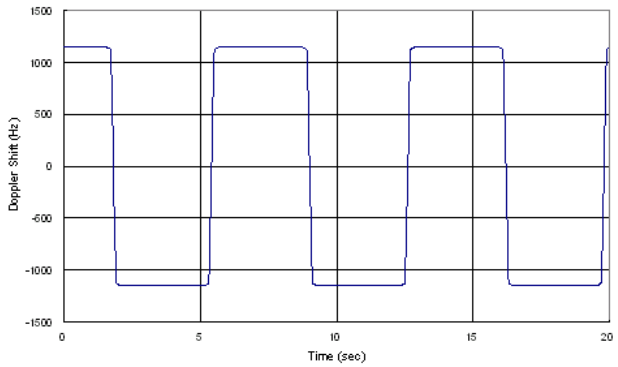


Fig. 4-9: Doppler shift trajectory for scenario 3

Doppler shift calculation

The HST scenarios are defined for the UE and for the BS tests. In the fading simulator, the same standards are used for both test cases. Consider however, the following difference in the calculation of the Doppler shift:

- In *HST UE tests*, the resulting Doppler shift is based *only* on the used DL frequency.
- In *HST BS tests*, the DL signal itself already contains a Doppler shift. The UE synchronizes on this shifted DL frequency. The simulated UL signal contains a Doppler shift, too.
  The resulting Doppler shift is than based *on both*, the UL and the DL frequency.

To enable the fading simulator to consider the DL Doppler shift, use the following two parameters:

- Consider DL RF
- Virtual DL RF

General recommendations on performing HST BS tests

The following is a list of the general steps required to enable the fading simulator to generate the signal required for the HST BS tests

1. Set the "RF Frequency" of the instrument to the F_{UL}, as defined in the specification.
2. Enable a high speed train scenario with extension "(DL+UL)" in its name.
3. If not enabled, activate the parameter "Fading > (HST) Path Table > Consider DL RF > On".
4. Set the value of the parameter "Fading > (HST) Path Table > Virtual DL RF" to the F_{DL}, as defined in the specification.

Example: Configuring the fading simulator to generate a HST BS test signal according to 3GPP TS36.104

For frequency Band 1 tests, the specification defines: F_{DL} = 2.14 GHz and F_{UL} = 1.95 GHz. The resulting Doppler shift is F_D = 1140 Hz.

- In the status bar, select "Frequency = F_{UL} = 1.95 GHz"
- Select "Fading A > Fading Settings > Standards" and navigate to the required high speed train scenario "3GPP > High Speed Train > HST 3 Tunnel Multi Antenna (DL +UL)"
- If not enabled, activate the parameter "Fading > Path Table > Consider DL RF > On".
- Select "Fading > Path Table > Virtual DL RF = F_{DL} = 2.14 GHz"
- Select "Fading > Fading Settings > State > On"
- Use the command `[:SOURce<hw>]:FSIMulator:HSTRain:FDOPpler?` to query the resulting Doppler shift.

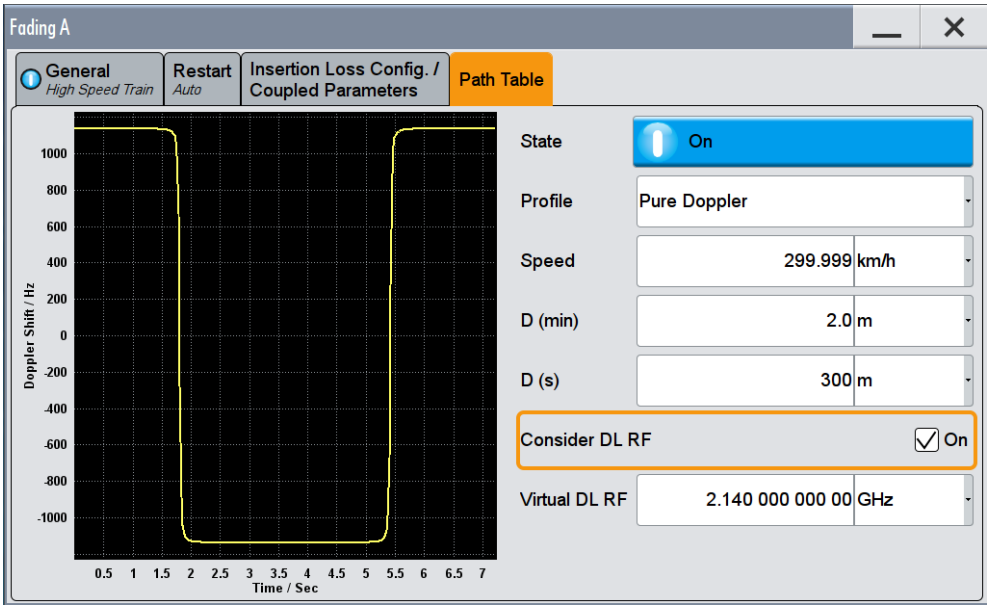
Compare the example below and the Doppler shift trajectory specified in the 3GPP TS36.104.

High Speed Train Scenario Settings

To access these settings:

1. Select "Fading > Fading Settings > Standards".
2. Navigate to the required high speed train scenario, e.g. "3GPP > High Speed Train > HST 3 Tunnel Multi Antenna (DL+UL)"

   The "3GPP HST" dialog displays the default values of the High Speed Train scenarios and allows you to adjust them for further tests.



State
Activates/deactivates simulation of High Speed Train propagation according to the selected scenario.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:STATe` on page 157

Profile
Determines the fading profile for the selected scenario. The fading profile determines which transmission path is simulated.

Although both scenarios 1 and 3 are specified as Pure Doppler paths without a fading profile and scenario 2 as a Rician fading, in this fading simulator you can change the fading profile.

"Static Path" A static transmission path with no attenuation (loss) or delay is simulated.

"Pure Doppler" A transmission path is simulated in which there is an individual direct connection from the transmitter to the moving receiver (discrete component).
The simulated path has a constant delay and attenuation (no loss).
The Doppler frequency shift is determined only by the parameters Speed, D (min) and D (S).
Tip: Use the SCPI command `[:SOURce<hw>]:FSIMulator:HSTRain:FDOPpler?` to query the Doppler frequency shift.

"Rayleigh" A radio hop is simulated in which many highly scattered subwaves arrive at a moving receiver.

"Rice" One Rician fading propagation channel with K (Rician factor) and with one tap is simulated.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:PROFile` on page 156

Speed
Sets the velocity parameter, i.e. the speed of the moving receiver.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:SPEed` on page 155

D (min)
Determines the parameter D_{min}, i.e. the distance between the BS and the railway track.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:DISTance:MINimum` on page 154

D (S)
Determines the parameter D_S, i.e. the initial distance $D_S/2$ between the train and the BS at the beginning of the simulation.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:DISTance:STARt` on page 154

K (Rician factor)
For scenario 2, sets the Rician factor K that is defined as the ratio between the dominant signal power and the variant of the other weaker signals.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:KFACtor` on page 156

Consider DL RF
Enables the selection of virtual downlink frequency (DL RF).

By default, this parameter is enabled for the HST (DL+UL) standards. For detailed description, see "Doppler shift calculation" on page 74.

Note: While performing HST BS tests and "Consider DL RF > Off", the DL Doppler shift is not considered by the calculation of the UL Doppler shift.

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:DOWNlink:FREQuency:STATe` on page 156

Virtual DL RF
Sets the virtual downlink frequency. For HST BS tests, enter the F_{DL} defined in the specification. The value is used by the calculation of the UL Doppler shift.

For detailed description, see "Doppler shift calculation" on page 74

Remote command:
`[:SOURce<hw>]:FSIMulator:HSTRain:DOWNlink:FREQuency` on page 156

4.10 Custom Fading Profile

The custom fading profile allows you to modify the classical Jakes and Flat fading profiles. These modified profiles are required by the IEEE 802.11p channel models.

A frequency offset f_{offset} can be applied to shift the spectrum of the original profile. Two cut-off frequencies, f_l (lower) and f_u (upper), can be configured to set the lower and upper cut-off frequencies of the resulting spectrum, see figure 4-10.

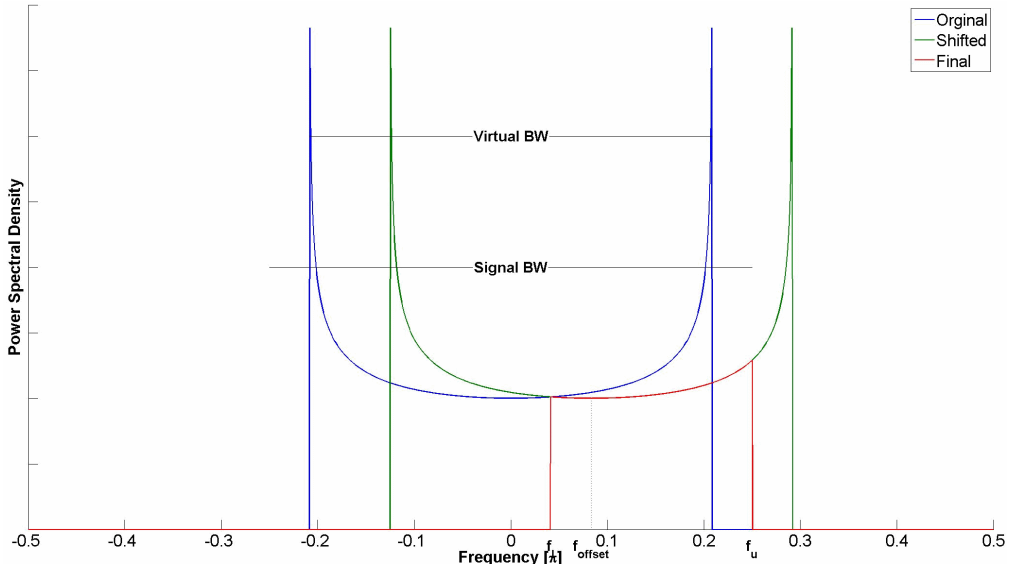


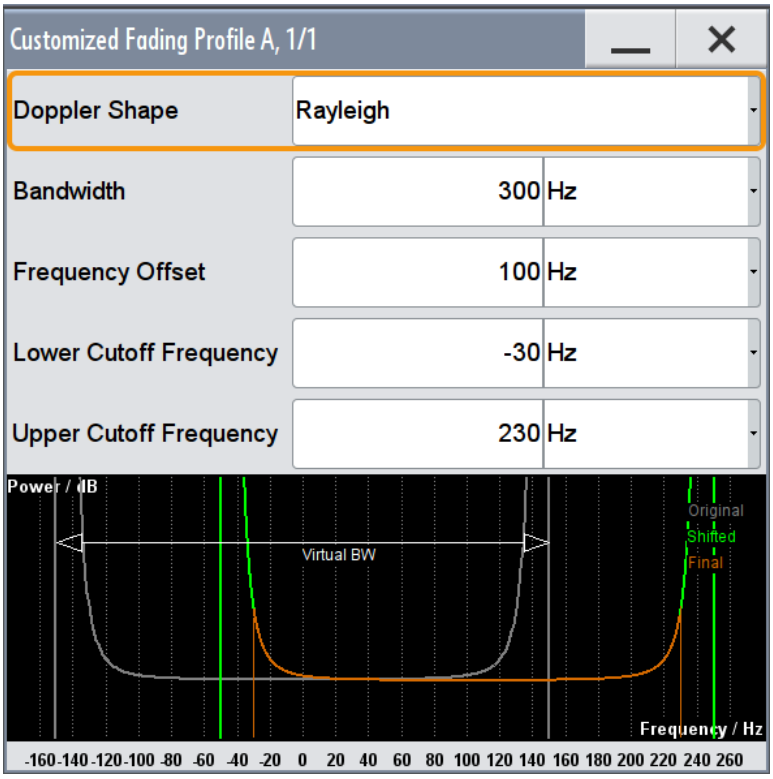
Fig. 4-10: Resulting asymmetric Doppler spectrum

In the Fading Simulator, all these required profile parameters are configurable, see "Custom Fading Profile Settings" on page 78.

Custom Fading Profile Settings

To access these settings:

1. Select "Fading > Fading Settings > Path Table"
2. Select "Profile > Custom"
3. Select "Custom Profile > Custom Data"



Doppler Shape
Sets the Doppler shape ("Flat" or "Rayleigh") of the virtual profile.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DSHape` on page 186

Bandwidth
Sets the bandwidth of the original Doppler profile from which the resulting profile is created, see figure 4-10.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DATA` on page 187

Frequency Offset
Sets the f_{offset}, i.e. the frequency offset used to shift the original profile, see figure 4-10.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DATA` on page 187

Lower/Upper Cutoff Frequency
Sets the lower and upper cut-off frequencies, f_l and f_u, that depend on the original profile bandwidth Bandwidth.

The following applies:
- $f_u \leq f_{offset} + Bandwidth/2$

- $f_l \geq f_{offset}$ - *Bandwidth*/2
- $f_u - f_l \geq 50\ Hz$
- 50 Hz ≤ Bandwidth ≥ 40 kHz

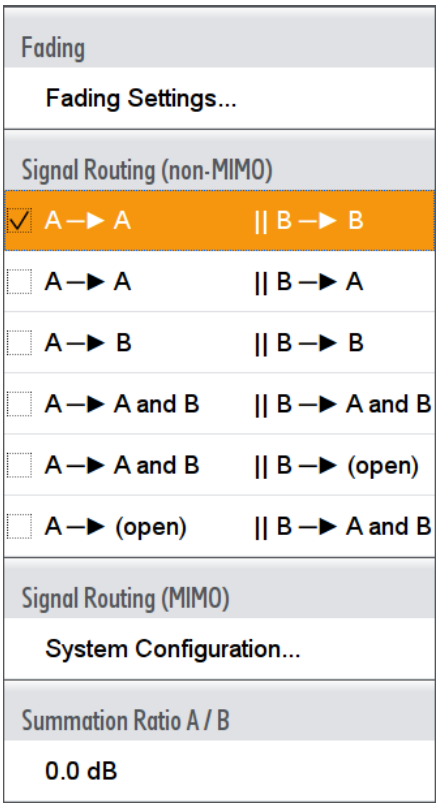
Where the highest possible absolute cut-off frequency is 4 kHz.

Remote command:
`[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DATA` on page 187

5 Signal Routing (non-MIMO) Settings

These settings are available in "System Configuration > Mode > Standard", i.e. in non-MIMO scenarios.

► To access the signal routing settings, select "Fading > Signal Routing (non-MIMO)".


Fading
Fading Settings...
Signal Routing (non-MIMO)
A —► A || B —► B
A —► A || B —► A
A —► B || B —► B
A —► A and B || B —► A and B
A —► A and B || B —► (open)
A —► (open) || B —► A and B
Signal Routing (MIMO)
System Configuration...
Summation Ratio A / B
0.0 dB

Signal Routing
In "System Configuration > Mode > Standard", defines the signal routing for the fading signal at the output of the fading simulator.

Note: Signal routing for MIMO setups is performed with the settings provided in section "MIMO > System Configuration" (see also chapter 6.2, "Signal Routing Settings in MIMO Configuration", on page 85).
In remote control, however, all available signal routing settings are configured with the command `[:SOURce<hw>]:FSIMulator:ROUTe`.

In "System Configuration > Mode > Standard", the input signal of the fading simulator is defined by the setting "Baseband > Signal Routing". An instrument equipped with two fading simulators and two baseband blocks, the input signal of each of the fading simulator can be:

- the signal from a single baseband block,
- the summation signal from both baseband blocks or
- each a signal from one of the two baseband blocks.

The following is a list of the routing settings for an instruments equipped with two baseband blocks, two signal paths and two options Fading Simulator (R&S SMW-B14).

"A to A/ B to B" Dual-channel fading. The fading signal from fader A is output on baseband path A and the fading signal from fader B is output on baseband path B.
The R&S SMW can be operated like two instruments; two independently configured signals are routed to the instrument's output.

This configuration is also suitable for transmit or receive diversity tests:

- Use the signal of one of the baseband generators to simulate the receiving conditions of a receiver with two antennas, like a high-quality car radio, UMTS base station, etc.
- Correlate the paths of the two fading simulators, i.e. the two fading channels, to simulate the conditions of receiver with two antennas which receive statistically correlated signals, like a car with two antennas in which the two received signals exhibit a certain degree of correlation due to a similar environment such as an underpass, hill, etc

"A to A/B to A" Dual-channel fading. The fading signal from fader A and the fading signal from fader B are both output on baseband path A.
This configuration is suitable for the simulation of a mobile radio network handover in the handheld device or for testing of filtering out the own signal in case of simultaneous presence of a strong signal from another standard. To simulate the required conditions, configure each of the baseband signals according to the desired standard and route them to the fading simulator. After fading, the two signals with widely divergent signal strengths are output on a common output path.

"A to B / B to B"
Dual-channel fading. The fading signal from fader A and the fading signal from fader B are both output on baseband path B.

"A to A and B / B to A and B"
Dual-channel fading. The fading signal from fader A and the fading signal from fader B are output on baseband path A and baseband path B.
The possible applications are basically analogous to the "A to A / B to A" routing. With this routing however, the signal at the output of the fading simulator is split up and routed to both paths; the processing of these two paths after the fading can be differently. To simulate a further degradation of the receiving conditions, for instance, use the provided function to superimpose the signal of one of the paths by noise or destroy it.

"A to A and B / B (open)"
The fading signal from fader A is output on baseband path A and baseband path B. The signal from fader B is not output, the signal flow of baseband B is interrupted.

"A (open)/ B to A and B"

The fading signal from fader B is output on baseband path A and baseband path B. The signal from fader A is not output, the signal flow of baseband A is interrupted.

Remote command:

`[:SOURce<hw>]:FSIMulator:ROUTe` on page 124

6 Multiple Input Multiple Output (MIMO)

Provided that the instrument is equipped with the required options, the R&S SMW supports versatile MIMO configurations.

Section chapter 3.1, "Required Options", on page 17 provides an overview; for detailed information, refer to the R&S SMW data sheet.

Multiple Input Multiple Output (MIMO) refers to a multi-channel method where two or more simultaneous channel inputs and channel outputs are being used for boosting data rates. The benefits of an MIMO system became visible only if the data signal is tested in fading conditions. The MIMO fading option considers this special form of multipath propagation in channel simulation.

Depending on the number of the transmitting and receiving antennas used in a MIMO system, different MxN MIMO test configurations are specified. The term MxN is a representation of a MIMO system, where M is the number of the transmitting Tx antennas and N the number of the receiving Rx antennas. Throughout this description, we also use the term LxMxN as a short form of the used system configuration, where L represents the Number of Entities, M the Number of Basebands (Tx Antennas) and N the Number of Stream (Rx Antennas).

Normally, the simulation of a system with two or more transmitting and/or receiving antennas requires two or more signal generators and/or fading simulator. The MIMO Fading option (R&S SMW-K74) in combination with up to four Fading Simulator options (R&S SMW-B14) enables you to simulate MIMO receiver tests scenarios with up to 8 Tx or up to 8 Rx antennas with one single instrument (see also chapter 6.1, "Multiple Entity MxN MIMO Test Configurations", on page 85).

Configurations with more than two entities as well as the higher order MIMO configurations require the additional options Multiple Entities (R&S SMW-K76) and Higher Order MIMO (R&S SMW-K75).

Abstract representation of the signal routing

2x2 MIMO system	Preview diagram	Block diagram

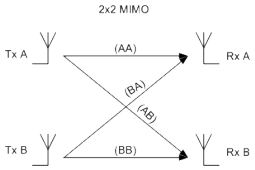
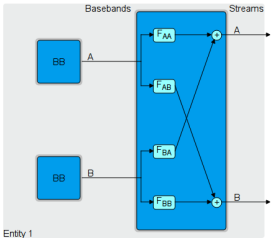
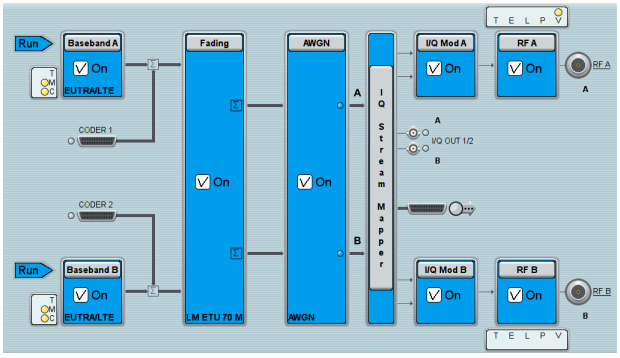

		

Illustration of the principle	Detailed representation of the signal processing Each $F_{<Tx><Rx>}$ block represents one MIMO channel	"High level" representation The Fading Simulator is displayed as one single block; the number of the input Basebands (M) and the output Streams (N) indicate the MxN MIMO configuration.

The representation of a multi-entity MIMO configuration is even more abstract (see also chapter 6.1, "Multiple Entity MxN MIMO Test Configurations", on page 85).

6.1 Multiple Entity MxN MIMO Test Configurations

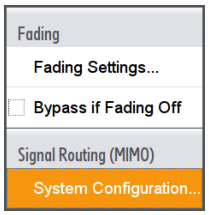
Equipped with the MIMO Fading option (R&S SMW-K74), the instrument enables the simulation of versatile MIMO tests scenarios with one single instrument.

The supported MIMO scenarios depend on the installed options, in particular on the number of options fading simulator (R&S SMW-B14), i.e. the number of the available FADER boards and on the availability of the options Multiple Entities (R&S SMW-K76) and and Higher Order MIMO (R&S SMW-K75).

For more details, see the data sheet.

6.2 Signal Routing Settings in MIMO Configuration

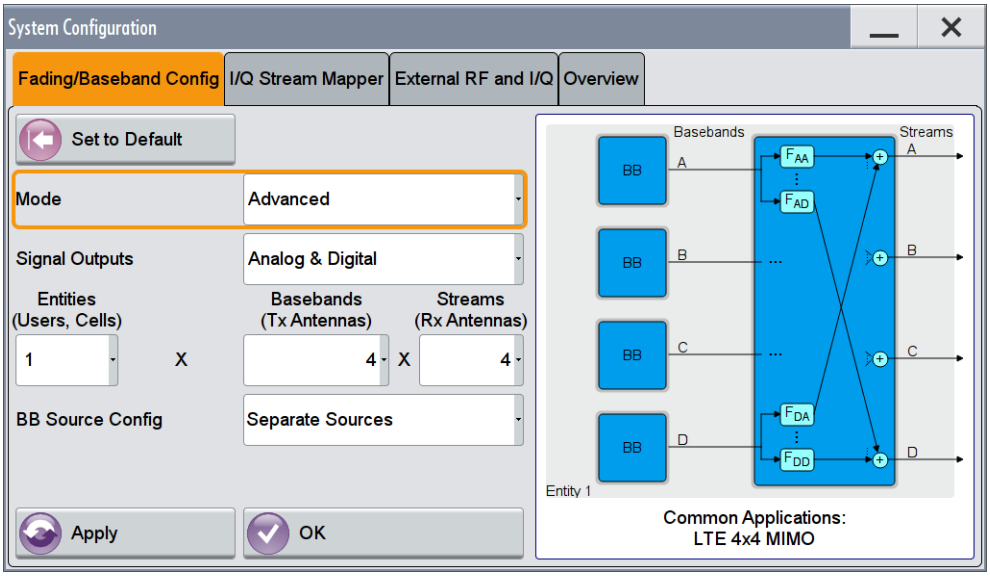
You have to select and configure a MIMO scenario before you can define the further fading settings or the signal routing through the instrument.



To enable a MIMO scenario

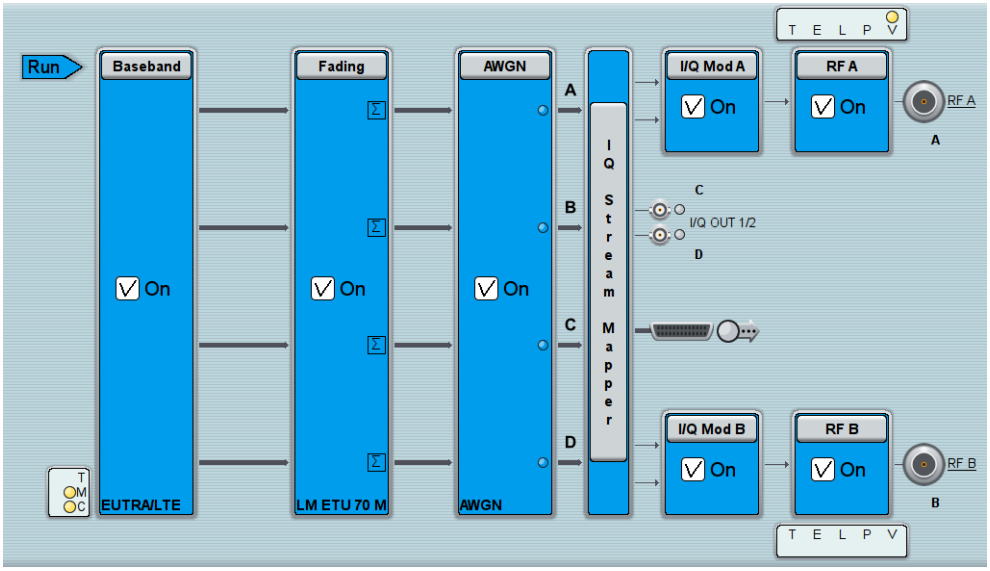
1. Select "Fading > MIMO > System Configuration"
2. In the "System Configuration > Fading/Baseband Configuration" dialog, enable "Mode > Advanced"
3. Define the MIMO scenario, e.g. to configure a 1x4x4 MIMO select:
   a) "Entities (Users, Cells) = 1"
   b) "Basebands (Rx Antennas) = 4"
   c) "Streams (Tx Antennas) = 4"
   d) "BB Source Config > Coupled Sources"

   The preview diagram displays a detailed view of the signal routing for the current selected configuration, together with short description of the possible application of this configuration.



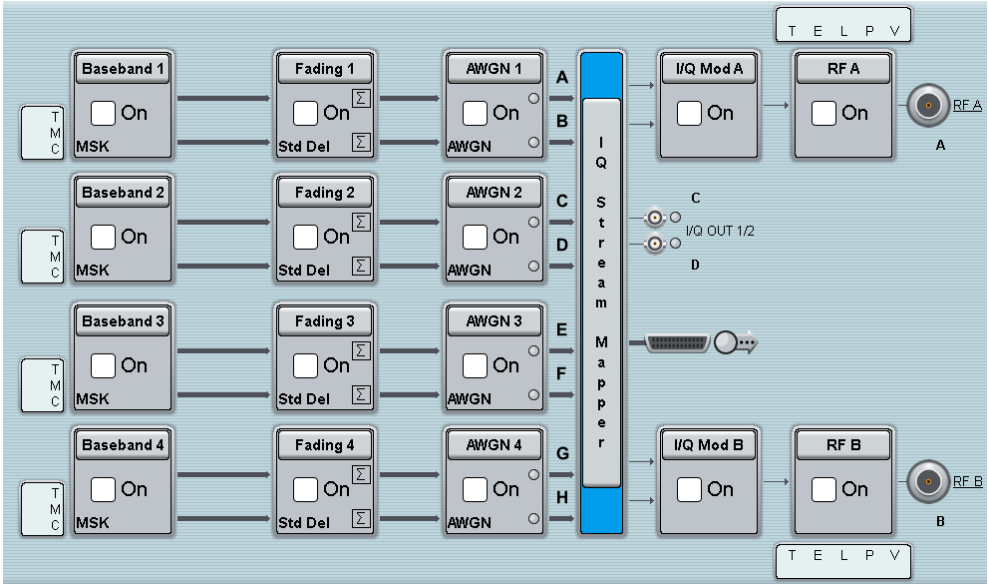
4. Select "Fading/Baseband Configuration > Apply" to trigger the instrument to use the selected configuration and close the dialog.

   The block diagrams displays the configured signal routing.



5. To enable a multiple-entities configuration, select "System Configuration > Fading/Baseband Configuration" and enable for example:

   a) "Mode > Advanced"
   b) "Entities (Users, Cells) = 4", "Basebands (Rx Antennas) = 2", "Streams (Tx Antennas) = 2"
   c) "BB Source Config > Coupled Sources per Entity"
   d) "Apply".



Refer to chapter 6.3, "Fading Settings in MIMO Configuration", on page 87 for description on the provided MIMO Fading settings.

Refer to section "Signal Routing and System Configuration" in the R&S SMW user manual for comprehensive description of the settings in the "System Configuration" dialog as well as information on how to define the I/Q stream mapping, connect external instruments, etc.

To define the signal routing in MIMO mode

In MIMO mode, the signal routing is performed upon the selected MIMO configuration.

► Configure the instrument for a MIMO scenario, see "To enable a MIMO scenario" on page 85.

The signal routing is fixed and depends on the selected MIMO configuration.

6.3 Fading Settings in MIMO Configuration

The MIMO Fading settings are available if a MIMO scenario is configured.

1. Configure the instrument for a MIMO scenario, see "To enable a MIMO scenario" on page 85.
2. You can access the dialog for configuring the MIMO settings of all MIMO channel via each of the "Fading" blocks.
   Select "Fading > Fading Settings".

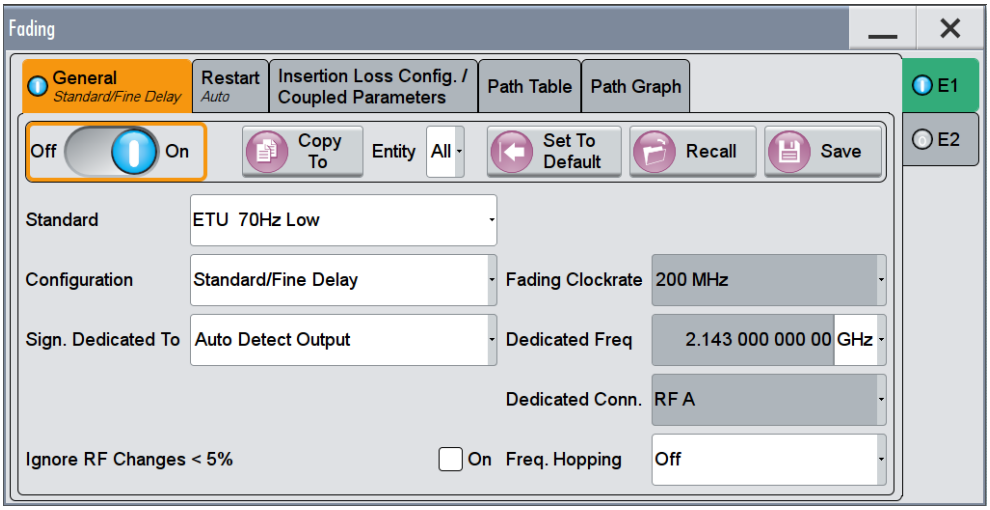


Fig. 6-1: General settings in "System Configuration > 2x2x2" (multi entity mode, L=2)

In "System Configurations" with multiple entities (L > 1), the dialog consists of more than one side tabs; one tab per entity. The tab name indicates the fader state the settings are related to.

3. Select "Path Table".

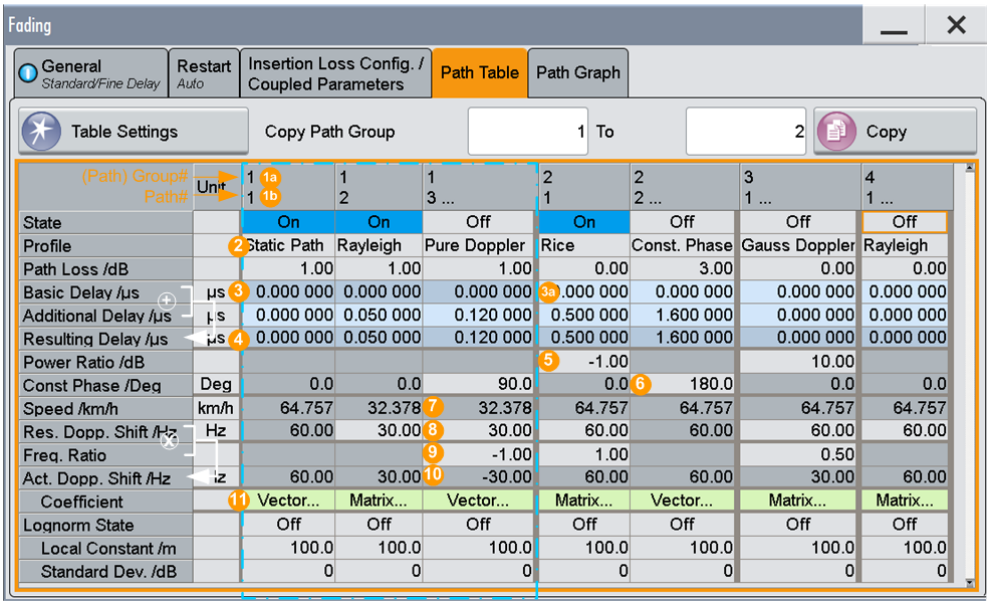


Fig. 6-2: Path table settings in single entity mode (L=1): Understanding the displayed information

1a/1b = Path group number (displayed in the first row) and path number (second row in the table header); the example shows 4 groups with different number of active paths (the first group is marked with a blue border)

2 = Fading profile, assigned per fading path

3/3a = Common group delay of a path group ("Basic Delay" is always 0 for group 1); adjustable for the other groups (light grey background)

4 = Resulting delay per path, calculated as the sum of the common group delay and the path-specific delay.

5 = Adjustable parameter for paths with Rice fading
6 = Pure display parameters are on a dark background
7 = Access to a "Vector" or a "MIMO Matrix" for configuration of the correlation between the channels

4. In the path table, navigate to the row "Coefficient" and for the corresponding path select "Matrix" or "Vector".

   The "Fading: Correlation Matrix" dialog comprises the parameters necessary to adjust the correlation between the channels. You can define the correlation in one of the following ways:

   - In "Matrix Mode > Individual"

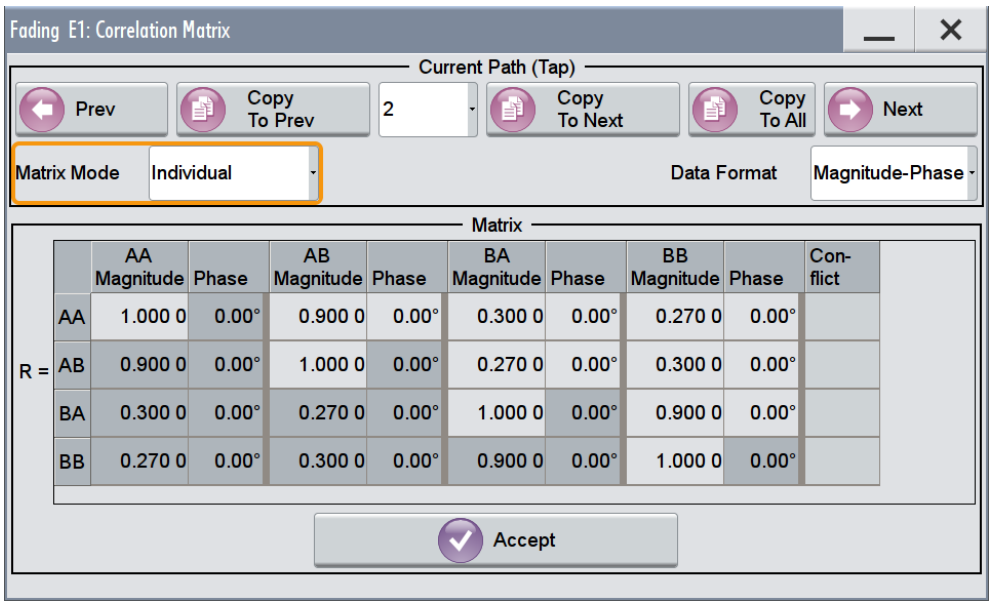


Fig. 6-3: Correlation matrix in an individual matrix mode

   In this mode, you can adjust the matrix coefficients directly in the coefficient matrix.

   - In "Matrix Mode > Kronecker"

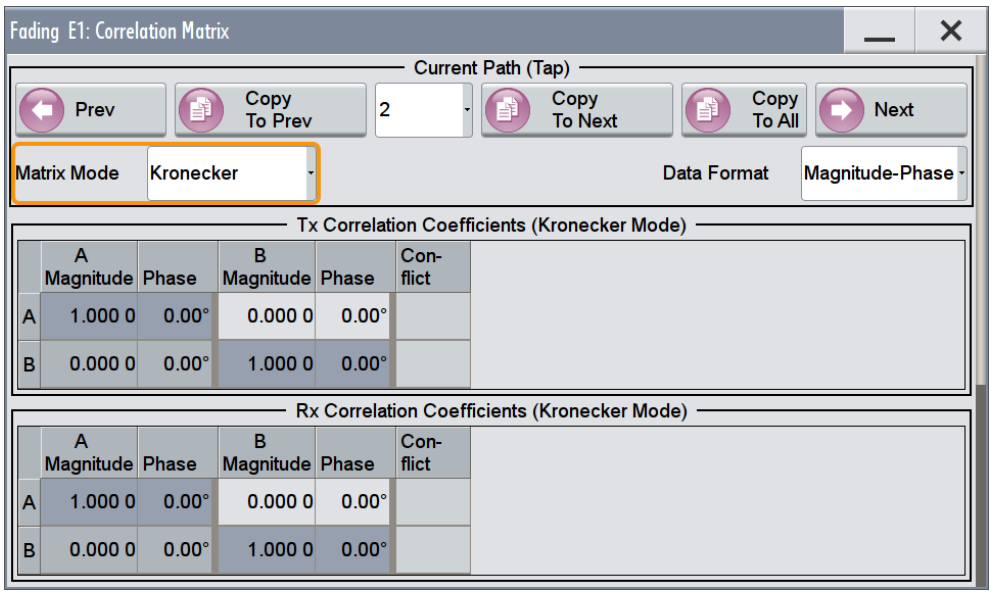


Fig. 6-4: Correlation matrix in the kronecker mode

The definition of the correlation matrix settings is based on the Kronecker assumption, i.e defined are the Rx and Tx antenna correlation coefficients. The instrument calculates automatically the resulting correlation matrix and displays it.

See chapter 6.3.2, "Kronecker Mode Correlation Coefficients", on page 93.

- In "Matrix Mode > AoA/AoD"

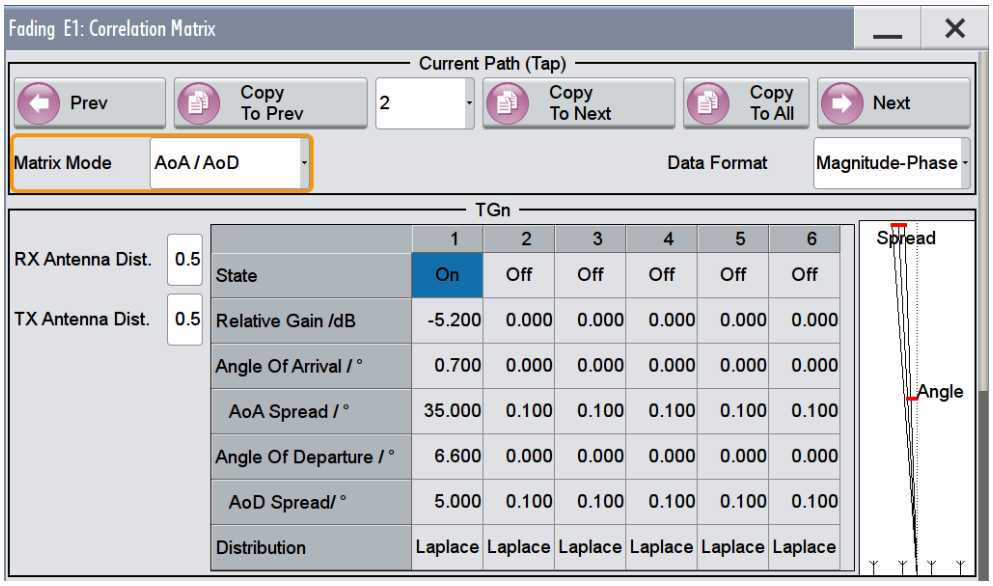
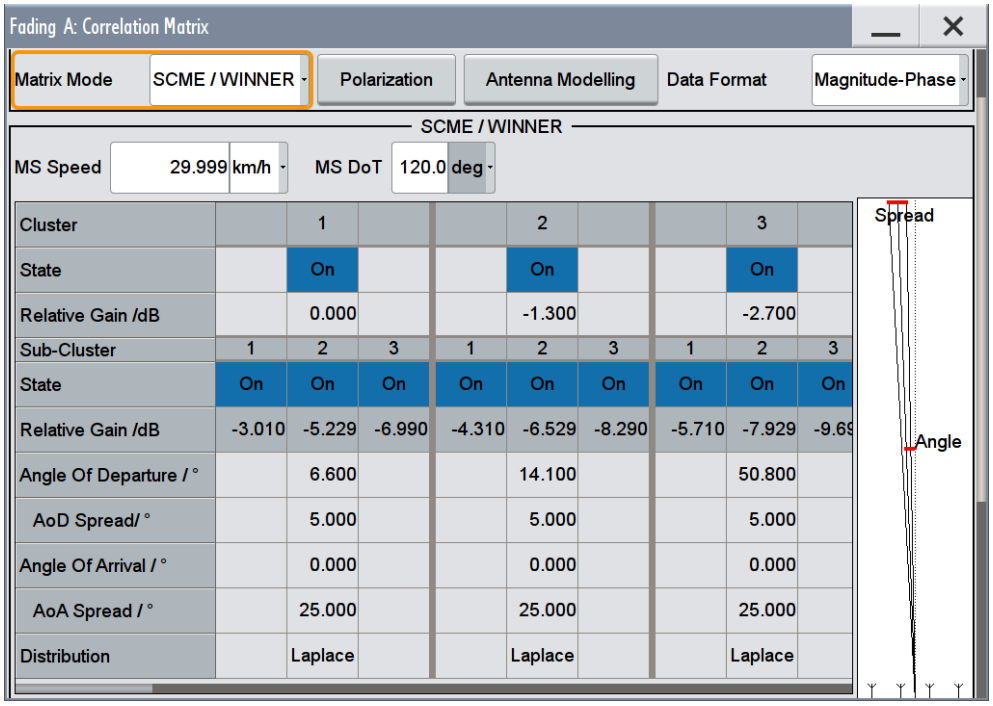


Fig. 6-5: Correlation matrix in TGn format (AoA/AoD mode)

See chapter 6.3.3, "TGn/TGac Channel Models Settings", on page 96.

- In "Matrix Mode > SCME/WINNER"



See chapter 6.3.4, "SCME/WINNER Models and Antenna Modeling Settings", on page 98.

- For static paths and paths with Pure Doppler fading profile, the corresponding settings are grouped in the "Relative Tap Gain Vector" dialog.

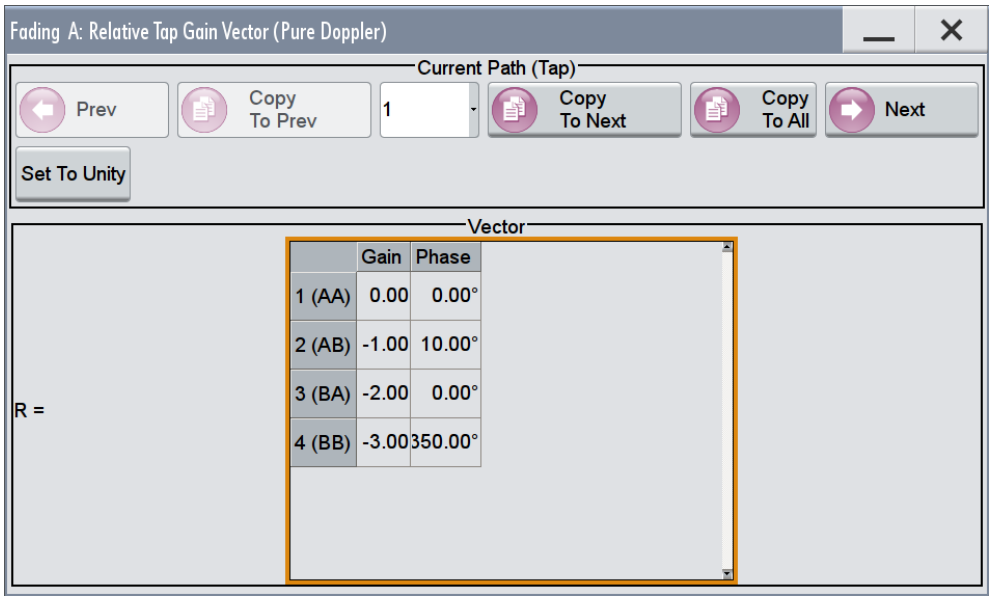


Fig. 6-6: Relative tap gain vector

This dialog provides additional parameters to simulate a gain weighting and phase shift between the signals with constant fading transmitted among the different Tx antennas.
See chapter 6.3.6, "Relative Gain Vector Matrix Settings", on page 111.

6.3.1 Current Path (Tap) Settings

Prev
Displays the previous tap relative to the current tap. If tap 1 is the current tap, this button is disabled.

Remote command:
`n.a.`

Copy To Prev
Copies the matrix values of the current tap to the next lower tap. If tap 1 is the current tap, this button is disabled.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:COPY:PREVious` on page 164

Current Path (Tap) #
Selects the tap to be displayed.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP` on page 164

Copy To Next
Copies the matrix values of the current tap to the next higher tap. If the current tap is the last tap, this button is disabled.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:COPY:NEXT` on page 163

Copy To All
Copies the matrix values of the current tap all taps.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:COPY:ALL` on page 163

Next
Displays the next tap relative to the current tap. If the current tap is the last tap, this button is disabled.

Remote command:
`n.a.`

Matrix Mode
Selects the input mode for the Rx and Tx correlation values.

"Individual" Allows entering the correlation values individually.

"Kronecker" Opens additional input fields for entering the Rx correlation and Tx correlation values, see chapter 6.3.2, "Kronecker Mode Correlation Coefficients", on page 93.
The matrix values are calculated automatically.

"AoA / AoD" Opens additional input fields for defining the Rx and TX correlation parameters based on the Spatial Channel Model (SCM), see chapter 6.3.3, "TGn/TGac Channel Models Settings", on page 96.
The matrix values are calculated automatically.

"SCME / WINNER" Opens additional input fields for defining the parameters of the Spatial Channel Model Extended (SCME) model, see chapter 6.3.4.1, "SCME/WINNER Settings", on page 100.
The matrix values are calculated automatically.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:MODE` on page 167

Polarization, Antenna Modeling
Accesses the corresponding tab in the "Antenna Model" dialog, see chapter 6.3.4, "SCME/WINNER Models and Antenna Modeling Settings", on page 98.

Data Format
Selects the matrix representation format. The data format can be changed at every time. The matrix table is updated immediately.

"Magnitude-Phase"
Displays the matrix values as value pairs of magnitude and phase.

"Real-Imag" Displays the matrix values as complex numbers.

Remote command:
`n.a.`

6.3.2 Kronecker Mode Correlation Coefficients

► To access the settings of the correlation matrix in Kronecker mode, enable a MIMO configuration, select the "Fading > Path Table > Matrix" and select "Fading: Correlation Matrix > Matrix Mode > Kronecker".

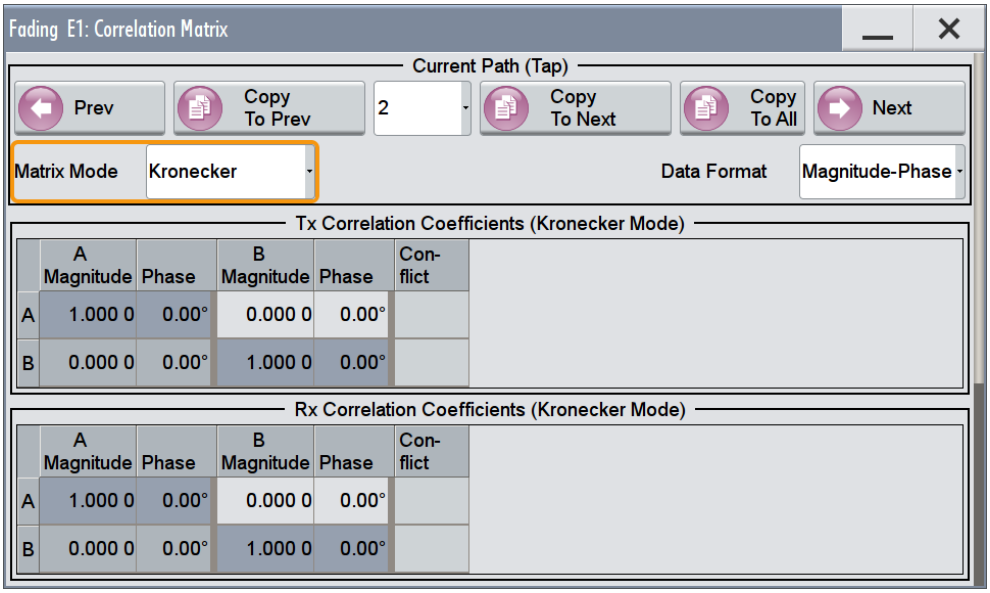


Fig. 6-7: Correlation matrix in Kronecker mode

Calculating of the matrix values based on the Kronecker assumption

In Kronecker mode, it is sufficient that you specify one Tx and one Rx correlation per MIMO channel. The instrument automatically computes the full correlation matrix according to the formula:

$$R_l = R_{\mathrm{Tx}}^{(l)} \otimes R_{\mathrm{Rx}}^{(l)}, \text{ where } R_{\mathrm{Tx}}^{(l)} = \begin{bmatrix} 1 & \rho_{\mathrm{Tx}}^{(l)} \\ \rho_{\mathrm{Tx}}^{(l)*} & 1 \end{bmatrix} \text{ and } \mathrm{R}_{\mathrm{Rx}}^{(l)} = \begin{bmatrix} 1 & \rho_{\mathrm{Rx}}^{(l)} \\ \rho_{\mathrm{Rx}}^{(l)*} & 1 \end{bmatrix}$$

where $\rho^{(l)}_{Rx}$ and $\rho^{(l)}_{Tx}$ are the R_x and T_x correlations.

The evaluation of the Kronecker product $\otimes$ leads to:

$$R_l = \begin{bmatrix} 1 & \rho_{\mathrm{Rx}}^{(l)} & \rho_{\mathrm{Tx}}^{(l)} & \rho_{\mathrm{Tx}}^{(l)}\rho_{\mathrm{Rx}}^{(l)} \\ \rho_{\mathrm{Rx}}^{(l)*} & 1 & \rho_{\mathrm{Tx}}^{(l)}\rho_{\mathrm{Rx}}^{(l)*} & \rho_{\mathrm{Tx}}^{(l)} \\ \rho_{\mathrm{Tx}}^{(l)*} & \rho_{\mathrm{Tx}}^{(l)*}\rho_{\mathrm{Rx}}^{(l)} & 1 & \rho_{\mathrm{Rx}}^{(l)} \\ \rho_{\mathrm{Tx}}^{(l)*}\rho_{\mathrm{Rx}}^{(l)*} & \rho_{\mathrm{Tx}}^{(l)*} & \rho_{\mathrm{Rx}}^{(l)*} & 1 \end{bmatrix}$$

Which and how many coefficients are available, depends on the selected MIMO configuration, e.g. any of the 2x2, 4x2, and 3x2 MIMO configurations, requires only one Rx correlation coefficient AB, whereas there are six Rx correlation coefficients in case of 2x4 MIMO configuration.

Tx Correlation Coefficients, Magnitude/Real
Enters the value for the real/ratio part of the transmitter correlation ($\rho^{(l)}_{Tx}$).

The available Tx correlation coefficients depends on the selected MIMO mode.

Remote command:
For "Data Format > Magnitude-Phase"
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:MAGNitude` on page 165
For "Data Format > Real-Imag"
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:REAL` on page 166

Tx Correlation Coefficients, Phase/Imag
Enters the value for the phase/imaginary part of the transmitter correlation ($\rho^{(I)}_{Tx}$).

The available Tx correlation coefficients depends on the selected MIMO mode.

Remote command:
For "Data Format > Ratio-Phase"
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:PHASe` on page 165
For "Data Format > Real-Imag"
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:IMAGinary` on page 165

Rx Correlation Coefficients, Magnitude/Real
Enters the value for the real/ratio part of the receiver correlation ($\rho^{(I)}_{Rx}$).

The available Rx correlation coefficients depends on the selected MIMO mode.

Remote command:
For "Data Format > Magnitude-Phase"
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:MAGNitude` on page 165
For "Data Format > Real-Imag"
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:REAL` on page 166

Rx Correlation Coefficients, Phase/Imag
Enters the value for the phase/imaginary part of receiver correlation ($\rho^{(I)}_{Rx}$).

The available Rx correlation coefficients depends on the selected MIMO mode.

Remote command:
For "Data Format > Ratio-Phase"
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:PHASe` on page 165
For "Data Format > Real-Imag"
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:IMAGinary` on page 165

6.3.3 TGn/TGac Channel Models Settings

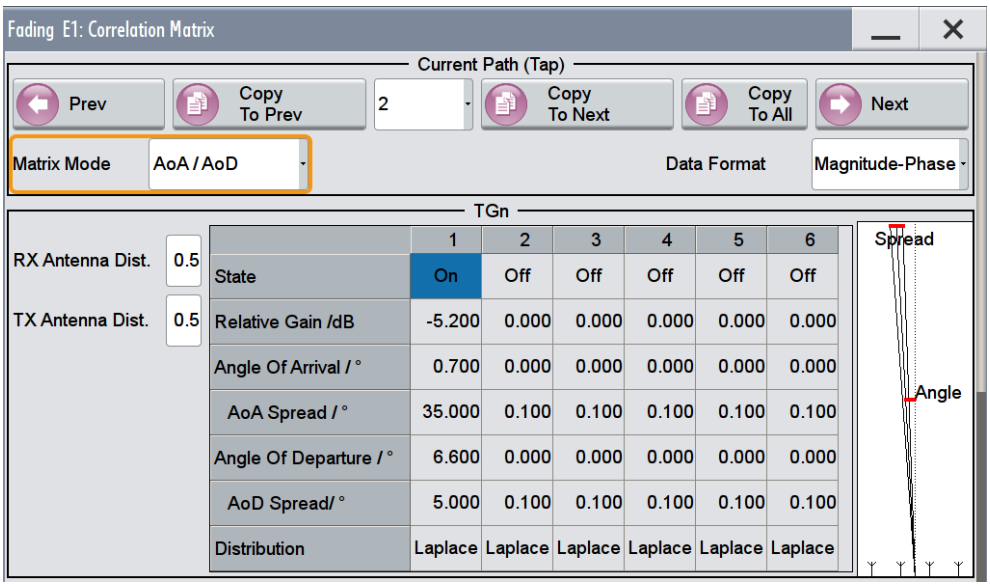
TGn and TGac channel models are specified for the evaluation of IEEE 802.11n and IEEE 802.11ac systems respectively.

These channel models are based on the so called rays, which are defined at the BS and MS side by their AoA (Angle of Arrival) and the AoD (Angle of Departure). The rays are distributed according to the selected statistic function and angle spread (AS).

In this implementation, one fading path consists by default of one ray but you can define up to six rays per path. The AoA (Angle of Arrival) / AoD (Angle of Departure) parameters, i.e. AoA/AoD angles, angle spreads (AS) and distribution of the rays, as well as the distances between the antennas at the Tx and the Rx side, are configurable.

To access the dialog with TGn/TGac settings

1. Enable a MIMO configuration, select the "Fading > Path Table > Matrix".
2. Select "Fading: Correlation Matrix > Matrix Mode > AoA/AoD".


Fading E1: Correlation Matrix
Current Path (Tap)
Prev
Copy To Prev
2
Copy To Next
Copy To All
Next
Matrix Mode
AoA / AoD
Data Format
Magnitude-Phase
TGn
RX Antenna Dist.
0.5
TX Antenna Dist.
0.5
1 2 3 4 5 6
State On Off Off Off Off Off
Relative Gain /dB -5.200 0.000 0.000 0.000 0.000 0.000
Angle Of Arrival / ° 0.700 0.000 0.000 0.000 0.000 0.000
AoA Spread / ° 35.000 0.100 0.100 0.100 0.100 0.100
Angle Of Departure / ° 6.600 0.000 0.000 0.000 0.000 0.000
AoD Spread/ ° 5.000 0.100 0.100 0.100 0.100 0.100
Distribution Laplace Laplace Laplace Laplace Laplace Laplace
Spread
Angle

RX/TX Antenna Distance
Determines the distance between the Tx and Rx antennas as function of the wave length lambda and is calculated as follow:

*Physical Antenna Distance = "RX/TX Antenna Distance" * λ*, where

the wave length *λ = c / "Frequency"* and *c* is the speed of light.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TGN:ANTenna:DISTance:RX` on page 173
`[:SOURce<hw>]:FSIMulator:MIMO:TGN:ANTenna:DISTance:TX` on page 173

Ray State
Enables/disables the selected ray.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:STATe` on page 175

Relative Gain /dB
Sets the relative gain (in dB) of the selected ray.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:GAIN` on page 174

Angle of Arrival (AoA)
Sets the AoA (Angle of Arrival) of the selected ray.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:ARRival:ANGLe` on page 174

AoA Spread
Sets the AoA (Angle of Arrival) spread (AS) of the selected ray.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:ARRival:SPRead` on page 174

Angle of Departure (AoD)
Sets the AoD (Angle of Departure) of the selected ray.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:DEParture:ANGLe` on page 174

AoD Spread
Sets the AoD (Angle of Departure) spread (AS) of the selected ray.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:DEParture:SPRead` on page 174

Distribution
Select one of the proposed statistical functions to determine the distribution of the selected ray.

Tip: Use this parameter to simulate ray scattering due to obstacles with different surface (see also chapter 8.8, "TGn Settings", on page 172).

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:DISTribution` on page 173

6.3.4 SCME/WINNER Models and Antenna Modeling Settings

The SCME and WINNER II channel models were developed by WINNER [1]. At the beginning the SCM (Spatial Channel Model) was adopted, the SCME (SCM Extension) was the first extension of the original model. The WINNER II was the final model the WINNER published.

The SCME and WINNER II channel models offer Cluster Delay Line (CDL) models for reduced complexity simulations. These CDL models can be simulated in the SCME/ WIINER matrix mode. A channel correlation matrix is calculated from the CDL parameters and the channel is stochastically simulated.

Antenna Modeling

The antenna modeling includes the antenna array structure, the antenna polarization and the antenna radiation pattern.

The antenna model is based on a 2D planar antenna array structure. The antenna elements are placed in the vertical and horizontal direction in an array composed of N columns and M rows (see figure 6-8). The antenna elements are uniformly spaced where the horizontal and vertical spacing between the antenna columns are d_h*λ and d_v*λ respectively. The spacing between the antenna pairs of cross polarized antennas is denoted as cross polarized antenna spacing d_{xp}*λ.

One of four different antenna polarization settings can be selected for all antenna elements in the antenna array.

In the current firmware version, the antenna elements are placed on a single row and vertical spacing is not supported.

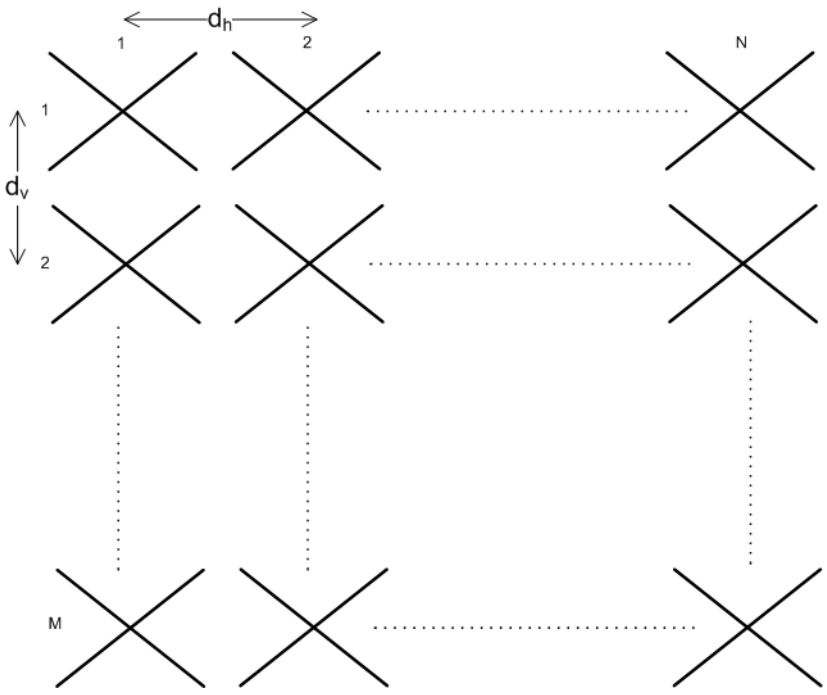


*Fig. 6-8: 2D planar antenna array structure where each column is a cross-polarized 45° antenna with dxp=0*λ*

The user interface illustrates the selected antenna array similarly, see Tx/Rx Antenna Array Structure.

Antenna and channel polarization

The polarization of an antenna is the polarization of the radiated electromagnetic fields produced by an antenna, evaluated in the far field.

Available are antenna elements with following polarizations:

- horizontal polarization
- vertical polarization
- cross-polarization 45°
- cross-polarization 90°

The correlation polarization matrix of the channel is computed from the antenna element polarization angles and the XPR (cross polarization power ration of a propagation channel) values, see "Vertical/Horizontal Cross Polarization Power Ratio" on page 106.

Channel correlation matrix

The total **channel correlation matrix R** is computed by the element-wise product of the polarization correlation matrix R_P and the spatial correlation matrix R_S, i.e. **$R = R_P * R_S$**.

The polarization and spatial correlation matrices, R_P and R_S are calculated as follows:

- **Spatial correlation matrix Rs**

The spatial correlation matrix is determined by the spatial characteristics of the channel, i.e. antenna radiation patters at the transmitter and the receiver ends, antenna spacings and the PAS of the clusters.
The correlation between antenna array elements n and m can be expressed as [2].

$$\rho_{n,m} \frac{\int_{-\pi}^{\pi} e^{-j2\pi\frac{d}{\lambda}\sin\emptyset} PAS(\emptyset)\sqrt{G_n(\emptyset)G_m(\emptyset)}d\emptyset}{\sqrt{\int_{-\pi}^{\pi} PAS(\emptyset)G_n(\emptyset)d\emptyset}\sqrt{\int_{-\pi}^{\pi} PAS(\emptyset)G_m(\emptyset)d\emptyset}}$$

Where:

- **d** is the antenna spacing between the two antenna elements
- **λ** is the wavelength of the signal
- **PAS (Ø)** is the Power Azimuth Spectrum of the impinging signal
- **G_n (Ø)** and **G_m(Ø)** are the antenna radiation patterns, characterized by a power gain, for antenna elements n and m respectively

Assuming that the transmitter and receiver sides as uncorrelated, the total spatial channel correlation matrix can be computed by the Kroneker product of the of the two correlation matrices.
$R_S=R_{Rx}\otimes R_{Tx}$

- **Polarization correlation matrix R_P**
  The polarization of the system is described by three matrices: channel polarization S, and P_{Tx}, P_{Rx} for the transmitter and receiver antenna array polarization respectively.
  It is assumed that the elements of the channel polarization matrix are uncorrelated.

For description of the related settings, see:

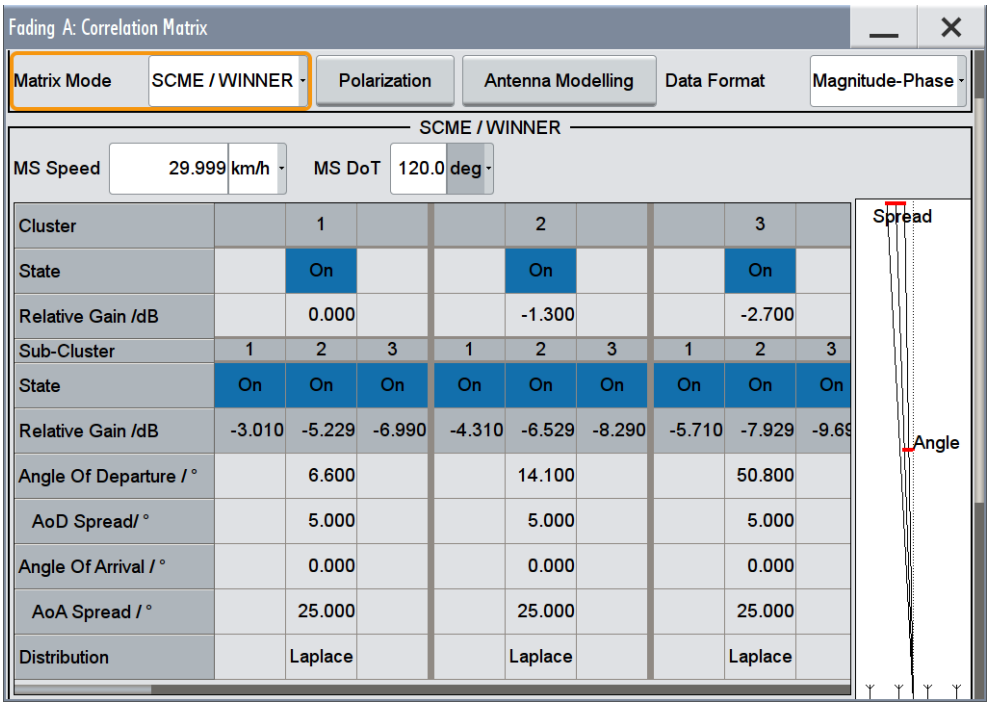
- chapter 6.3.4.1, "SCME/WINNER Settings", on page 100
- "Channel Polarization Settings" on page 106
- "Tx/Rx Antenna Array Structure" on page 107

6.3.4.1 SCME/WINNER Settings

To access these setting

1. Enable a MIMO configuration.
   See "To enable a MIMO scenario" on page 85.
2. Select "Fading > Path Table > Matrix"

3. Navigate to the required "Tap" and select "Fading: Correlation Matrix > Matrix Mode > SCME / WINNER"



With the provided settings you can define up to 20 clusters, each of which comprising of up to 3 sub-clusters.
A cluster is defined with its AoA (Angle of Arrival) / AoD (Angle of Departure) parameters, i.e. AoA/AoD angles, angle spreads (AS) and a relative gain. If an sub-cluster is enabled, its is additionally attenuated; the 3 sub-clusters powers are fixed ratios of the total cluster power (see Relative Gain /dB < Sub-Cluster)
Different Power Azimuth Spectrum (PAS) distributions can be used to describe the distribution of the selected cluster; however, all clusters simulated in one path should have the same distribution.

MS Speed 101
MS DoT (Direction of Travel) 102
Cluster State 102
Relative Gain /dB 102
State < Sub-Cluster 102
Relative Gain /dB < Sub-Cluster 102
Angle of Departure (AoD) 103
AoD Spread 103
Angle of Arrival (AoA) 103
AoA Spread 103
Distribution 103

MS Speed
Sets the speed of the mobile station.

This value determines the value of the parameter "Speed" (see Path Table > Speed).

Remote command:
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:TAP<st>:SPEed on page 176

MS DoT (Direction of Travel)
Sets the direction of travel of the mobile station.

If LOS (line-of-sight) is simulated, then the mobile station direction of travel determines the value of the parameter Frequency Ratio for Rice fading profile.

Remote command:
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:TAP<st>:DOT on page 177

Cluster State
Enables/disables the selected cluster.

Remote command:
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:STATe on page 177

Relative Gain /dB
Sets the relative gain (in dB) of the selected cluster.

Remote command:
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:GAIN on page 177

State < Sub-Cluster
If the corresponding cluster is enabled, you can enable up to 3 sub-clusters.

A cluster is comprises of 20 spatially separated sub-paths with equal powers. The sub-paths are occasionally split to sub-sets or sub-clusters (also known as mid-paths) having different resolvable delays. In the SCME and WINNER II models, one cluster can be split into 3 sub-clusters consisting of 10, 6 and 4 sub-paths resulting in 10/20, 6/20 and 4/20 relative power to the total cluster power respectively.

See also "Relative Gain /dB" on page 102.

Remote command:
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:SUBCluster<di>:STATe on page 179

Relative Gain /dB < Sub-Cluster
Displays the resulting relative attenuation, applied on an enabled sub-cluster. The value is determined based on the select "Relative Gain" of the cluster and is calculated as follows:

$RelativeGain_{Sub\text{-}Cluster}$[dB] =$RelativeGain_{Cluster}$[dB] + GainFactor [dB], where the used gain factors are listed in table 6-1.

Initially proposed by the SCME, these values are part of the SCME Urban Micro-Cell (UMi) und SCME Urban Macro-Cell (UMa) models used in the specification 3GPP 37.977.

Table 6-1: Overview: Gain factors and default relative gain values per sub-cluster

Sub-Cluster number	Gain Factor, W	Gain Factor, dB
1	10/20	-3.01
2	6/20	-5.229
3	4/20	-6.99

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:SUBCluster<di>:GAIN?` on page 179

Angle of Departure (AoD)
Sets the AoD (Angle of Departure) of the selected cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DEParture:ANGLe` on page 178

AoD Spread
Sets the AoD (Angle of Departure) spread (AS) of the selected cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DEParture:SPRead` on page 178

Angle of Arrival (AoA)
Sets the AoA (Angle of Arrival) of the selected cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:ARRival:ANGLe` on page 178

AoA Spread
Sets the AoA (Angle of Arrival) spread (AS) of the selected cluster.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:ARRival:SPRead` on page 178

Distribution
Select one of the Power Azimuth Spectrum (PAS) distributions to determine the distribution of the selected cluster. All clusters of the same tap must have the same distribution.

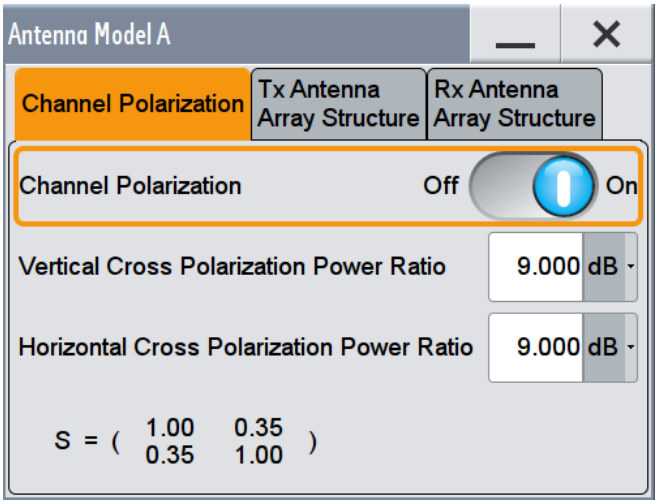
Tip: Use this parameter to simulate rays scattered due to obstacles with different surface (see also chapter 8.8, "TGn Settings", on page 172).

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DISTribution` on page 178

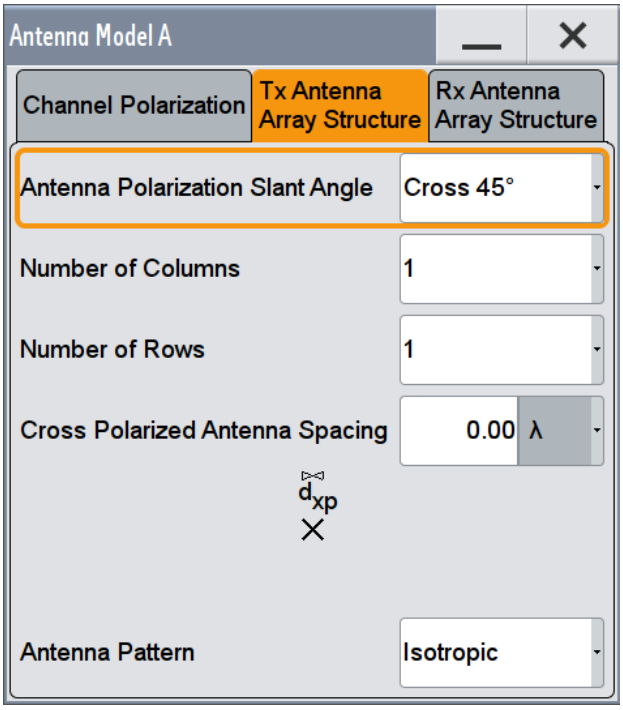
6.3.4.2 Channel Polarization and Antenna Modeling Settings

To access the "Antenna Modeling" dialog

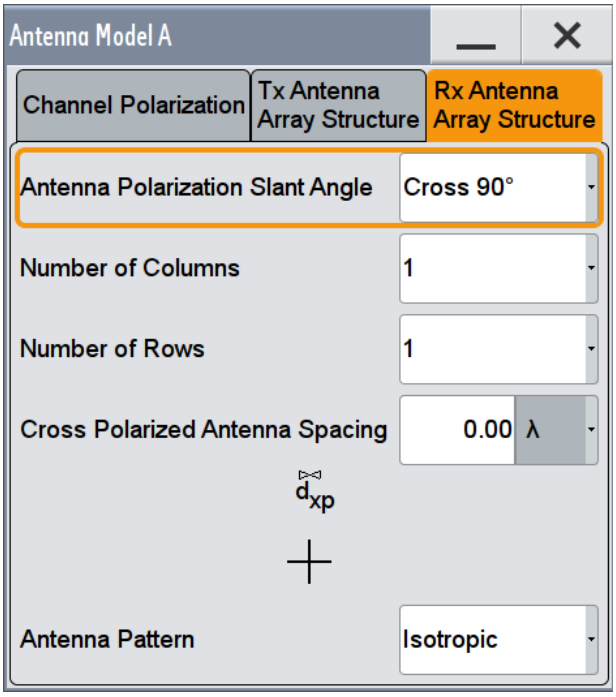
1. Enable a MIMO configuration, e.g. a 2x2 MIMO scenario.
   See "To enable a MIMO scenario" on page 85.
2. Select "Fading > Path Table > Matrix"
3. Navigate to the required "Tap" and select "Fading: Correlation Matrix > Matrix Mode > SCME / WINNER"
4. Select "Fading: Correlation Matrix > Polarization".



5. Select "Tx Antenna Array Structure" and configure a base station (BS) antenna polarization, e.g.:
   - "Slant Angle = Cross 45°"
   - "Cross Polarization Antenna Spacing = 0*λ"



6. Select "Rx Antenna Array Structure" and configure a mobile station (MS) antenna polarization, e.g.:
   - "Slant Angle = Cross 90°"
   - "Cross Polarization Antenna Spacing = 0*λ"



7. If required, change the "Antenna Pattern".

The selected 2D antenna pattern file describes the BS and MS antenna gains of each array element.

With the provided settings you can define the channel polarization and the antenna array polarization angles.

See also:

- "Channel correlation matrix" on page 99
- chapter 6.3.4.1, "SCME/WINNER Settings", on page 100

Channel Polarization Settings 106
└ Channel Polarization State 106
└ Vertical/Horizontal Cross Polarization Power Ratio 106
└ S 106
Tx/Rx Antenna Array Structure 107
└ Antenna Polarization Slant Angle 107
└ Number of Rows (M)/Columns (N) 107
└ Horizontal Spacing 108
└ Cross Polarized Antenna Spacing 108
└ Antenna Pattern 109
└ User Defined Antenna Patterns per Row, Column 109

Channel Polarization Settings
Comprises the channel polarization settings.

Channel Polarization State ← Channel Polarization Settings
Enables/disables simulation of channel polarization.

If "Channel Polarization > Off", the default parameter settings are used for simulation and not the current polarization settings.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:MODeling[:STATe]` on page 179

Vertical/Horizontal Cross Polarization Power Ratio ← Channel Polarization Settings
Sets the cross polarization power ratio (XPR) in dB.

$XPR_v = P_{vv}/P_{hv}$ and $XPR_h = P_{hh}/P_{vh}$

The resulting channel polarization matrix S is displayed.

Remote command:
`[:SOURce]:FSIMulator:MIMO:ANTenna:POLarization:PRATio:HORizontal` on page 180
`[:SOURce]:FSIMulator:MIMO:ANTenna:POLarization:PRATio:VERTical` on page 180

S ← Channel Polarization Settings
Displays the resulting *channel polarization* matrix S calculated as:

$$S = \begin{bmatrix} S_{vv} & S_{vh} \\ S_{hv} & S_{hh} \end{bmatrix}$$

Where:
- $S_{vv} = S_{hh} = 1$
- S_{vh} and S_{hv} are commonly designated as S_{xy} and are calculated from the equation
  E{Sxy²} = Pxy
  where:
  – E is the expectation, i.e. the mean power per polarization component
  – **P_{xy}** are derived from the selected Vertical/Horizontal Cross Polarization Power Ratio XPR.
- It is assumed that the elements of the channel polarization matrix are uncorrelated, i.e.:
  E{SijSlk*} = 0 for i != j, k != l

Tx/Rx Antenna Array Structure
Comprises the settings necessary to define the antenna elements, i.e. the antenna array structure and the antenna element radiation pattern for both, the transmit and receive antenna arrays.

A figure displays the structure of the current antenna array.

See also "Antenna Modeling" on page 98.

Antenna Polarization Slant Angle ← Tx/Rx Antenna Array Structure
Set the antenna element polarization slant angle.

Available are antenna elements with following polarizations:
- horizontal polarization
- vertical polarization
- cross-polarization 45°
  The slant 45° antenna is an "X" configuration. According to 3GPP TR 25.996, it is modeled as an ideal dipole with isotropic gain.
- cross-polarization 90°

A graph displays the structure of the current antenna array.

See also "Antenna Modeling" on page 98.

Remote command:
`[:SOURce]:FSIMulator:MIMO:ANTenna:RX:POLarization:ANGLe`
on page 181
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:POLarization:ANGLe`
on page 181

Number of Rows (M)/Columns (N) ← Tx/Rx Antenna Array Structure
Sets the number of rows (M) and the number of columns (N) in the antenna array, see "Antenna Modeling" on page 98.

Note: In this firmware version, only one dimensional arrays are supported.
You can define the "Horizontal Spacing" between the antenna elements but the antenna elements are placed in one row (i.e. "Number of Rows = 1").

Antennas with co-polarization use one antenna per column, whereas antennas with cross-polarization use two antennas per column.

The number of Tx and Rx antennas is set automatically according to the selected MxN MIMO configuration ("System Configuration > LxMxN").

See section "Signal Routing and System Configuration" in the R&S SMW user manual.

Example:

In an 1x4x2 MIMO configuration, there are 4 Tx and 2 Rx antennas.

The "Tx Antenna Array" consists of 4 antennas:

- if "Antenna Polarization Slant Angle > Horizontal/Vertical", these 4 antennas are placed in a row (4x1 array)
- if "Antenna Polarization Slant Angle > Cross-Polarization 45°/90°", there are exact 2 columns and 1 row.

The "Rx Antenna Array" contains exact 2 antennas, that can be distributed in one the following ways:

- if "Antenna Polarization Slant Angle > Horizontal/Vertical", in 2 columns and 1 row (2x1array)
- if "Antenna Polarization Slant Angle > Cross-Polarization 45°/90°", there is exact 1 column and 1 row

In both arrays, a distance d_{xp} may also exist between the cross polarized antenna elements.

Remote command:
`[:SOURce]:FSIMulator:MIMO:ANTenna:RX:COLumn:SIZE` on page 180
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ROWS:SIZE` on page 180

Horizontal Spacing ← Tx/Rx Antenna Array Structure
Sets the horizontal (d_h) physical distance between the antennas in the antenna array normalized by the wave length λ.

It is calculated as follows:

d_h= "Horizontal Spacing" * λ, where

the wave length λ = c / "Frequency" and *c* is the speed of light.

See also "Antenna Modeling" on page 98.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ESPacing:HORizontal` on page 181
`[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ESPacing:HORizontal` on page 180

Cross Polarized Antenna Spacing ← Tx/Rx Antenna Array Structure
Set the physical distance (d_{xp}) between the two antenna elements of an antenna with cross-polarization 45° or 90° normalized by the wave length λ .

It is calculated as follow:

d_{xp}= "Cross Polarized Antenna Spacing" * λ, where

the wave length λ = c / "Frequency" and *c* is the speed of light.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ESPacing:CROSs` on page 180
`[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ESPacing:CROSs` on page 180

Antenna Pattern ← Tx/Rx Antenna Array Structure
Antenna patterns are files that describe the 2D antenna radiation pattern.

Available are an "Isotropic" antenna and a "Dipole" antenna, as well as the two antenna patterns with different number of sectors ("3 Sectors" and "6 Sectors") that are required for the BS testing, as specified in the 3GPP TR 25.996.

You can also load a user defined antenna pattern, see "User Defined Antenna Patterns per Row, Column" on page 109.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:PATTern` on page 181
`[:SOURce]:FSIMulator:MIMO:ANTenna:RX:PATTern` on page 181

User Defined Antenna Patterns per Row, Column ← Tx/Rx Antenna Array Structure
Indicates the used antenna pattern file per antenna element.

To change the used file, select the antenna element, "Select Predefined/User File", navigate to the antenna pattern file and load it.

Antenna pattern files are XML files with file predefined file syntax and extension `*.ant_pat`.

They describe the antenna pattern as an array with typical resolutions of 1 to 5 degree for the azimuth. These files contain the loss values for a given azimuth.

For an isotropic antenna for instance, that radiates the energy equally in all directions, the array elements are all 0 dB.

For description of the file format, see chapter B, "Antenna Pattern File Format", on page 282.

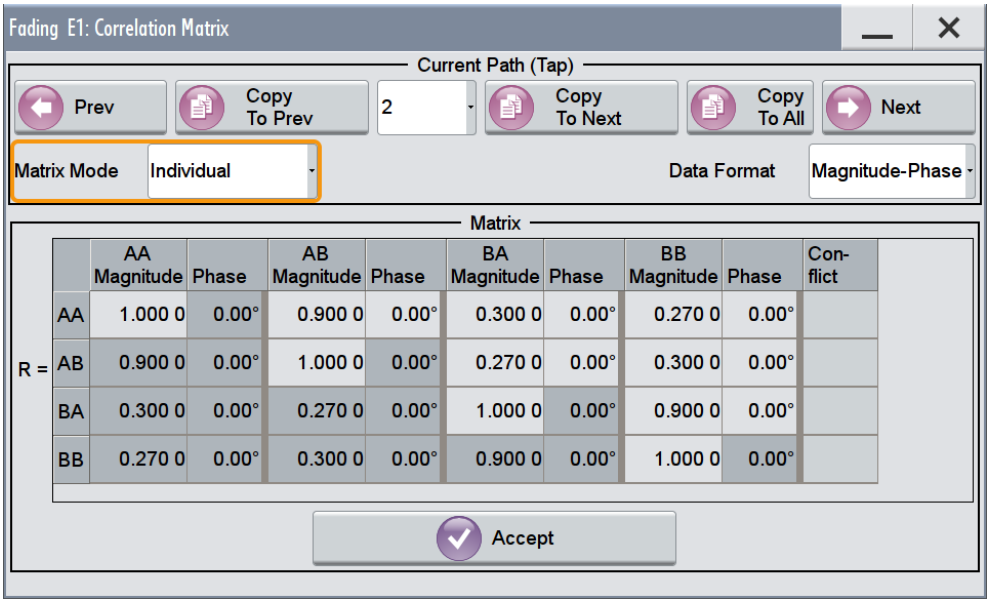
Remote command:
`[:SOURce]:FSIMulator:MIMO:ANTenna:PATTern:CATalog?` on page 180
`[:SOURce<hw>]:FSIMulator:MIMO:ANTenna<di>:TX:PFILe` on page 182
`[:SOURce]:FSIMulator:MIMO:ANTenna<di>:RX:PFILe` on page 182

6.3.5 Correlation Matrix Table

The correlation matrix table displays the values for the transmitter/receiver correlation. The correlation matrix is valid for the selected fading path. To adjust the values, edit the matrix elements directly, use the correlation coefficients of the Kronecker Mode, define the TGn/TGac parameters of the AoA /AoD mode or use the SCME/WINNER mode.

To access the settings of the correlation matrix in table form:

1. Enable a MIMO configuration
2. Select the "Fading > Path Table > Matrix" and navigate to "Fading: Correlation Matrix > Matrix".



Defining the matrix values individually

In individual matrix mode, you have to define the matrix values manually. Irrespectively of the selected data format, you have to enter valid correlation values.

Impossible calculation and conflict settings

The individual direct definition of the matrix elements may lead to impossible calculation due to inappropriate values and/or settings conflict.

You have to change the corresponding values.

The figure 6-9 uses a 2x2 MIMO matrix to depict the basic configuration principle.

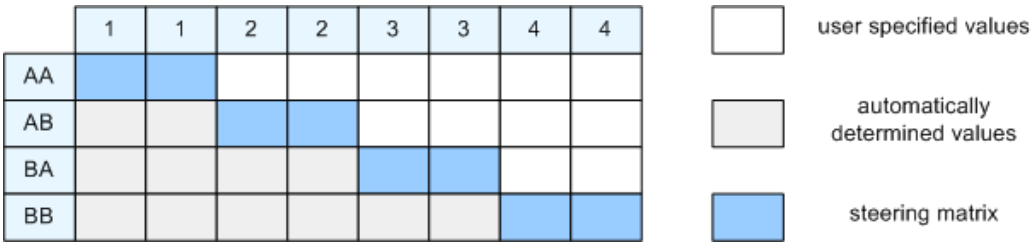


Fig. 6-9: Simplified representation of a 2x2 MIMO matrix

To define the matrix, set the only the value pairs in the diagonal and upper triangle (a total of 10 value pairs in this example, see figure 6-9). The instrument exploits the complex conjugate symmetry across the diagonal and determines automatically the remaining value pairs in the lower triangle.

By default, the values in the matrix diagonal are set to 1. Use values different than 1 to simulate antennas with different power level (steering).

Real/Magnitude
Enters the value for the real/ratio part of the correlation.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ROW<di>:COLumn<st>:MAGNitude` on page 168

Phase/Imag
Enters the value for the phase/imaginary part of the correlation.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ROW<di>:COLumn<st>:PHASe` on page 167

Conflict
Indicates a matrix conflict.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:CONFlict?` on page 167

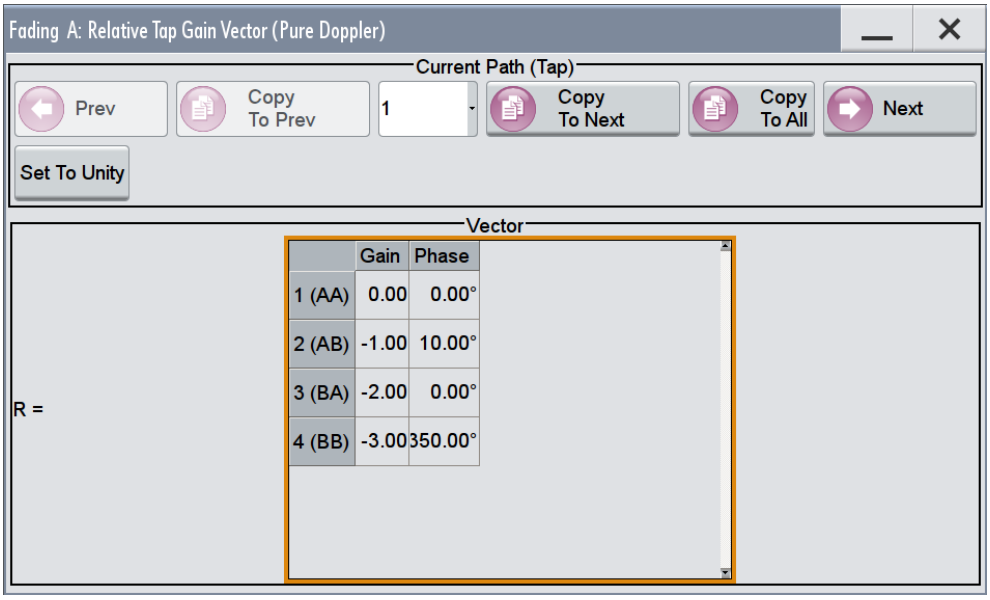
Accept
Accepts the values for the phase/imaginary and the real/ration part of the correlation.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ACCept` on page 166

6.3.6 Relative Gain Vector Matrix Settings

The "Fading: Relative Tap Gain Vector" dialog is available for static paths and paths with "Pure Doppler Fading Profile". This dialog provides additional parameters to simulate a gain weighting or phase shift between the signals with constant fading transmitted over the different Tx antennas.

1. To access this dialog, enable a MIMO configuration and select "Fading > Path Table > Profile > Static or Pure Doppler".
2. Select "Path Table > Coefficient > Vector".



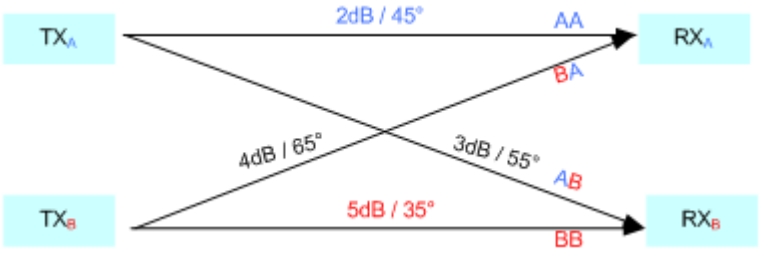
Use this function to simulate beamforming signal.

Example:

This example illustrates the phase shift between the signals with a start phase of 45 degrees, power level of 2 dB, and the gain and phase settings as follow:

- "AA Gain > 0", "AA Phase > 0"
- "AB Gain > -1", "AB Phase > 10"
- "BA Gain > -2", "BA Phase > 20"
- "BB Gain > -3", "BB Phase > 350"

Resulting simulation:



Set to Unity
Presets the vector matrix to an unitary matrix.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:PRESet` on page 168

Gain
Defines the relative gain of the selected path.

A gain value of 0 dB means no loss, and e.g. -3 dB is loss in this path.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AA:GAIN` on page 169
for the correct syntax of the SCPI command of the other paths, refer to the command description.

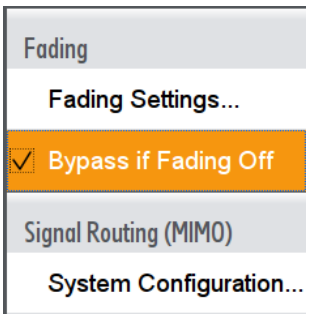
Phase
Defines the phase shift of the selected path.

Remote command:
`[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AA:PHASe` on page 170
for the correct syntax of the SCPI command of the other paths, refer to the command description.

6.4 Bypassing a Deactivated Fading Simulator

To access this setting, proceed as follow:

1. Enable "Fading > Signal Routing (MIMO) > System Configuration > Mode > Advanced".
2. Select "Fading > Off".
3. Select "Fading > Bypass if Fading Off > On".



The fading simulator is disabled and the input basebands bypass it.

Impact of the parameter on the calculation of the output streams

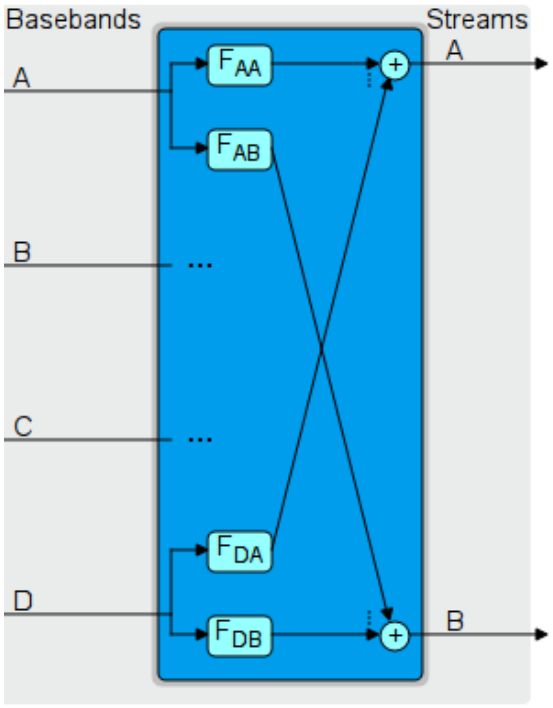
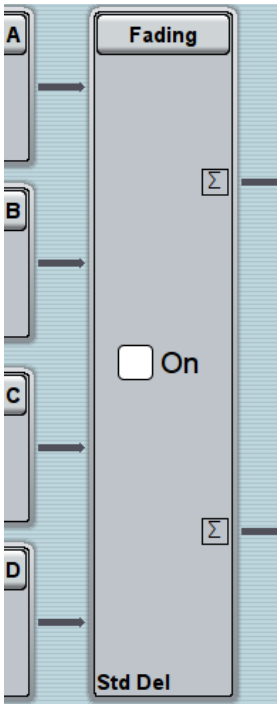
The parameter determines the way the output streams are calculated, if the fading simulator is disabled:

- Disabled parameter "Bypass if Fading Off" (default state)
  The fading simulator itself is disabled, but each output stream is still the linear combination of the input baseband signals and depend on the current MIMO configuration.

Example:

In a 4x2 MIMO system, for instance, the two output streams A and B are calculated from all the four input basebands. This instrument state is indicated by the sum symbols Σ at each output streams.

Table 6-2: Representation of the instrument state "Bypass if Fading Off > Off"

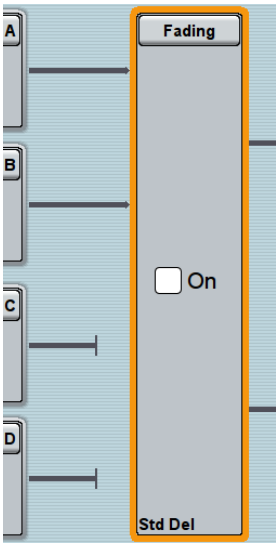
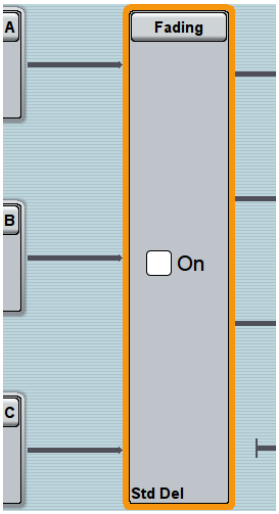
In the "System Configuration" preview diagram	In the block diagram
	

- Enabled parameter "Bypass if Fading Off"
  Bypasses the "Fading" block, i.e. the fading simulator is disabled and the basebands bypass unchanged the fading block.
  Depending on the MIMO configuration, the block diagram visualizes this behavior different (see table 6-3). The absence of the sum symbols confirm the selection, too.

Example:

- In a 4x2 MIMO system, for instance, the two output streams A and B are identical to the two input baseband signals A and B.
  The Basebands C and D are not processed.
- Vice versa, in a 3x4 MIMO system, the three output streams A, B and C are identical to the three basebands.
  The stream D is a zero stream that starts after the "Fading" block.

Table 6-3: "Bypass if Fading Off > On": Representation in the block diagram

MxN MIMO configuration, where M>N	MxN MIMO configuration, where M<N
	

"Bypass if Fading Off > ON" during troubleshooting

While performing troubleshooting, enable this parameter to exclude the impact of the fading in the signal processing.

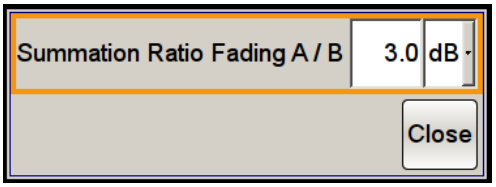
SCPI command:

`[:SOURce]:FSIMulator:BYPass:STATe` on page 119

7 Summation Ratio A/B

This parameter is available in "System Configuration > Mode > Standard", i.e. in non-MIMO scenarios.

► To access this settings, select "Fading > Summation Ratio A/B".



The "Summation Ratio A/B" setting is used to set the ratio of the output levels of both paths A and B in case the two faded signals are added.

Faded signals are added in case one of the following signal routing configuration (see also chapter 5, "Signal Routing (non-MIMO) Settings", on page 81):

- Signal Routing A to A / B to A
- Signal Routing A to B / B to B
- Signal Routing A to A&B / B to A&B

The "Summation Ration A/B" function is similar to the "Baseband Offsets > Path Gain" function in the "Baseband" block.

The "Path Gain" represents the relative gain of the selected path compared to the baseband signal of the other path and/or of the supplied external baseband signal. The "Path Gain" is measured at the output of the "Baseband" blocks and is considered in any signal routing with summed signals.

However, if the baseband signal is additionally faded and routed at the output of the fading simulator, so that the faded signals from both paths are summed, the real path gain is measured at the output of the "Fading" blocks and set with the parameter "Summation Ratio A/B".

The relative gain set with the parameter "Path Gain" in the "Baseband" block is ignored.

A positive value of the parameter "Summation Ration A/B" indicates a stronger signal on path A; respectively a negative value indicates a stronger signal on path B.

SCPI command:

`[:SOURce<hw>]:FSIMulator:SUM:RATio` on page 135

8 Remote-Control Commands

This subsystem contains the commands necessary to configure the fading simulator in a remote environment. We assume that the R&S SMW has already been set up for remote operation in a network as described in the R&S SMW documentation. A knowledge about the remote control operation and the SCPI command syntax are assumed.

Conventions used in SCPI command descriptions

For a description of the conventions used in the remote command descriptions, see section "Remote Control Commands" in the R&S SMW user manual.

Required Options

All SCPI commands described in this section, require at least the R&S SMW-B14 option. For better overview, this option is not listed at each command. Additionally required options, however, are listed.

The dynamic fading configurations (Birth Death, Moving Propagation, 2 Channel Interferer and High Speed Train) are available with option R&S SMW-K71.

See also chapter 3.1, "Required Options", on page 17.

Common Suffixes

The following common suffixes are used in remote commands:

Suffix	Value range	Description
`ENTity<ch>`	1 .. 8	entity in a multiple entity configuration `ENTity3|4|5|6|7|8` require option R&S SMW-K76
`SOURce<hw>`	[1]|2 .. 8	available faders `SOURce3|4|5|6|7|8` require option R&S SMW-K76 only `SOURce1` possible, if the keyword `ENTity` is used
`GROup<st>`	[1]|2...4	available fading path groups
`PATH<ch>`	[1]|2..5	available fading paths
`TAP<ch>`	[1]...10	available MIMO taps
`RAY<st>`	[1]...6	available SCM clusters/rays
`CLUSter<ch>`	[1]...20	available SCME/WIMMER clusters

Using SCPI command aliases for advanced mode with multiple entities

You can address multiple entities configurations by using the SCPI commands starting with the keyword `SOURce` or the alias commands starting with the keyword `ENTity`.

Note that the meaning of the keyword `SOURce<hw>` changes in the second case.

For details, see section "SCPI Command Aliases for Advanced Mode with Multiple Entities" in the R&S SMW user manual.

Programming examples

This description provides simple programming examples. The purpose of the examples is to present **all** commands for a given task. In real applications, one would rather reduce the examples to an appropriate subset of commands.

The programming examples have been tested with a software tool which provides an environment for the development and execution of remote tests. To keep the example as simple as possible, only the "clean" SCPI syntax elements are reported. Non-executable command lines (e.g. comments) start with two // characters.

At the beginning of the most remote control program, an instrument (p)reset is recommended to set the instrument to a definite state. The commands `*RST` and `SYSTem:PRESet` are equivalent for this purpose. `*CLS` also resets the status registers and clears the output buffer.

The following commands specific to the fading simulator are described here:

- General Settings 118
- Birth Death 139
- Delay Modes 143
- High Speed Train 153
- Moving Propagation 157
- MIMO Settings 162
- MIMO Vector Settings 169
- TGn Settings 172
- SCME, WINNER I, WINNER II and Antenna Model Settings 175
- 2 Channel Interferer 182
- Custom Fading Profile 186

8.1 General Settings

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[:SOURce<hw>]:FSIMulator:CONFiguration 119
[:SOURce<hw>]:FSIMulator:SISO:COPY 120
[:SOURce<hw>]:FSIMulator:COPY:DESTination 120
[:SOURce<hw>]:FSIMulator:COPY:EXECute 120
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[:SOURce<hw>]:FSIMulator:HOPPing:MODE 122
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[:SOURce<hw>]:FSIMulator:ILOSs[:LOSS] 123
[:SOURce<hw>]:FSIMulator:KCONstant 124
[:SOURce<hw>]:FSIMulator:PRESet 124
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[:SOURce<hw>]:FSIMulator:SPEed:UNIT....129
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[:SOURce<hw>]:FSIMulator:STORe....137
[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:CSTD....137
[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:LCONstant....137
[:SOURce<hw>]:FSIMulator:COUPle:SPEed....138
[:SOURce<hw>]:FSIMulator:CSPeed....138

[:SOURce]:FSIMulator:BYPass:STATe <BypState>

Enables/disables bypassing of the fading simulator if the simulator is deactivated.

Parameters:

<BypState> 0 | 1 | OFF | ON

*RST: 0

[:SOURce<hw>]:FSIMulator:CONFiguration <Configuration>

Sets the fading configuration.

To activate the selected fading configuration, use the remote-control command for switching the state.

Parameters:

<Configuration> STANdard | BIRThdeath | MDELay | UDYNamic | TCInterferer | HSTRain

STANdard|BIRThdeath|MDELay|TCInterferer|HSTRain
Defines the configuration: Standard delay, Birth Death Propagation, Moving Propagation, 2 Channel Interferer and High Speed Train propagation.

UDYNamic
The User Dynamic configuration is provided for future use.

*RST: STANdard

Example: `SOURce1:FSIMulator:CONFiguration MDELay`
selects a moving propagation configuration.
`SOURce1:FSIMulator:MDELay:STATe ON`
activates the moving propagation for fader A.

Manual operation: See "Configuration" on page 27

[:SOURce<hw>]:FSIMulator:SISO:COPY <CopyToDest>

In "System Configurations" with multiple entities (L > 2), copies the settings of the current fading simulator to all or to the selected entities.

Parameters:

<CopyToDest> FADB | FADA | FADC | FADD | FADF | FADE | FADG | FADH | ALL

*RST: ALL

Example: `SOURce1:FSIMulator:SISO:COPY ALL`

Options: R&S SMW-K76

Manual operation: See "Copy To / Entity" on page 25

[:SOURce<hw>]:FSIMulator:COPY:DESTination <Destination>

Selects a group whose settings will be overwritten.

Parameters:

<Destination> integer

Range: 1 to 4 (Standard Delay)/ 8 (Fine Delay)
*RST: 2

Example: see `[:SOURce<hw>]:FSIMulator:COPY:SOURce` on page 120

Manual operation: See "To" on page 43

[:SOURce<hw>]:FSIMulator:COPY:EXECute

Copies the settings of a fading path group to the selected one.

Example: see `[:SOURce<hw>]:FSIMulator:COPY:SOURce` on page 120

Usage: Event

Manual operation: See "Copy" on page 43

[:SOURce<hw>]:FSIMulator:COPY:SOURce <Source>

Sets the group whose settings are to be copied.

Parameters:

<Source> integer

Range: 1 to 8
*RST: 1

Example:
```
FSIM:DEL:STAT ON
FSIM:COPY:DEST 4
FSIM:COPY:SOUR 1
FSIM:COPY:EXEC
// copies the settings from group 1 to group 4
```

Manual operation: See "Copy Path Group" on page 43

[:SOURce<hw>]:FSIMulator:FREQuency <Frequency>

- If `[:SOURce<hw>]:FSIMulator:SDEStination` **RF** is selected, queries the estimated RF frequency.
- If `[:SOURce<hw>]:FSIMulator:SDEStination` **BB** is selected, sets the frequency used for the calculation of the Doppler shift.

Parameters:

<Frequency> float

Range: 1E5 to 100E9
Increment: 0.01
*RST: 1E9
Default unit: Hz

Example:
```
SOURce1:FSIMulator:SDEStination RF
SOURce1:FSIMulator:FREQuency?

SOURce1:FSIMulator:SDEStination BB
SOURce1:FSIMulator:FREQuency 2143200000
```

Manual operation: See "Dedicated Frequency" on page 32
See "Virtual RF" on page 32

[:SOURce<hw>]:FSIMulator:CLOCk:RATE?

Queries the clock rate the fading simulator is using for the signal processing.

Return values:

<ClockRate> CR200 | CR100 | CR050 | CR025

CR200 = 200 MHz, CR100 = 100 MHz, CR050 = 50 MHz, CR025 = 25 MHz

*RST: CR200

Usage: Query only

Manual operation: See "Fading Clock Rate" on page 29

[:SOURce<hw>]:FSIMulator:GLOBal:SEED <Seed>

This command enters the fading start seed. This value is global for the instrument.

Parameters:

<Seed> integer

Range: 0 to 9
*RST: 0

Example: `FSIM:GLOB:SEED 2`
sets the start seed to 2

Manual operation: See "Start Seed" on page 40

[:SOURce<hw>]:FSIMulator:HOPPing:MODE <Mode>

Activates frequency hopping and determines how fading is resumed after a frequency hop.

Note: Prior to activating frequency hopping, list mode and the desired frequency table must be activated.

Parameters:

<Mode> OFF | IBANd | OOBand

OFF
Frequency hopping is deactivated.

IBANd
Activates an in-band frequency hopping.

OOBand
Activates an out of band frequency hopping.

*RST: OFF

Example: `MMEM:CDIR "/var/user/fading"`
sets the default directory.
`LIST:SELect "fading1"`
selects the file `fading1` with the frequency values for the frequency hops.
`LIST:DWEL 2E-3`
sets a dwell time of 2 ms between two frequency hops.
`LIST:MODE AUTO`
selects untriggered list mode.
`FREQ:MODE LIST`
activates list mode.
`FSIM:HOPP:MODE IBAN`
activates an in band frequency hopping. The fading process is restarted after a hop back.

Manual operation: See "Freq. Hopping Mode" on page 33

[:SOURce<hw>]:FSIMulator:IGNore:RFCHanges <RfChanges>

(instruments with RF output only)

This command determines whether frequency changes < 5% are ignored. This enables faster frequency hopping.

Parameters:

<RfChanges> 0 | 1 | OFF | ON

*RST: 0

Example: `FSIM:IGN:RFCH ON`
Ignores frequency changes < 5% for the fading.

Manual operation: See "Ignore RF Changes < 5PCT" on page 32

[:SOURce<hw>]:FSIMulator:ILOSs:CSAMples?

This command queries the share of samples which were clipped due to the insertion loss setting.

Return values:

<CSamples> string

Example: `FSIM:ILOS:CSAM?`
queries the share of samples which were clipped.
`Response: 11`
11% of the samples were clipped.

Usage: Query only

Manual operation: See "Clipped Samples" on page 39

[:SOURce<hw>]:FSIMulator:ILOSs:MODE <Mode>

This command sets the insertion loss of the fading simulator.

Parameters:

<Mode> NORMal | LACP | USER

NORMal
The minimum insertion loss for a path of the fading simulator is set to a fixed value of 18 dB.

*RST: NORMal

Example: `FSIM:ILOS:MODE USER`
chooses the user-defined setting for the insertion loss.
`FSIM:ILOS 4 dB`
sets the minimum insertion loss to 4 dB.

Manual operation: See "Insertion Loss Mode" on page 38

[:SOURce<hw>]:FSIMulator:ILOSs[:LOSS] <Loss>

This command sets the user-defined insertion loss of the fading simulator when "User" is selected.

In the "Normal" and "Low ACP" modes, the current setting of the value can be queried.

Parameters:

<Loss> float

Range: -3 to 30
Increment: 0.1
*RST: 0
Default unit: dB

Example: `FSIM:ILOS:MODE USER`
chooses the user-defined setting for the insertion loss.
`FSIM:ILOS 4 dB`
sets the minimum insertion loss to 4 dB.

Manual operation: See "Insertion Loss" on page 38

[:SOURce<hw>]:FSIMulator:KCONstant <KConstant>

Selects whether to keep the speed or the resulting Doppler shift constant in case of frequency changes.

Parameters:

<KConstant> SPEed | DSHift

*RST: SPEed

Example: `FSIM:KCON SPE`
keeps the speed constant in case of frequency changes.

Manual operation: See "Keep Constant" on page 43

[:SOURce<hw>]:FSIMulator:PRESet

Sets the default settings (`*RST` values) for fading simulation.

Example: `SOURce1:FSIMulator:PRESet`

Usage: Event

Manual operation: See "Set to Default" on page 26

[:SOURce<hw>]:FSIMulator:RESTart:MODE <Mode>

Selects how a restart of fading simulation is triggered.

Parameters:

<Mode> AUTO

*RST: AUTO

Manual operation: See "Restart Mode" on page 34

[:SOURce<hw>]:FSIMulator:ROUTe <Route>

Selects on which baseband path the faded signal is output. The input signal of the fader is selected with command `SOURce:BB:ROUTe`.

For one-path instruments this command is query only. It returns value FAA (Fader A always outputs the signal on baseband A).

Note: All MIMO configurations are enabled only in `:SCONfiguration:MODE ADVanced`.

:SCONfiguration:MODE	:SCONfiguration:FADing <FadConfig>	[:SOURce<hw>]:FSIMulator:ROUTe
STANdard	FAAFBNone	FAMAXAB
	FAAFBB	FAAFBB
	FAAFBA	FAAFBA
	FABFBB	FABFBB
	FAABFBN	FAMAXAB
	FANFBAB	FBMAXAB
	FAABFBAB	FAABFBAB
ADVanced	MIMO1X2	FA1A2BFB1A2BM12
	MIMO1X3	FA1A2BFB1A2BM13
	MIMO1X4	FA1A2BFB1A2BM14
	MIMO2X2	FA1A2BFB1A2B|FA1A2BFB1A2BM22
	MIMO2X3	FA1A2BFB1A2BM23
	MIMO2X4	FA1A2BFB1A2BM24
	MIMO3X1	FA1A2BFB1A2BM31
	MIMO3X2	FA1A2BFB1A2BM32
	MIMO3X3	FA1A2BFB1A2BM33
	MIMO3X4	FA1A2BFB1A2BM34
	MIMO4X1	FA1A2BFB1A2BM41
	MIMO4X2	FA1A2BFB1A2BM42
	MIMO4X3	FA1A2BFB1A2BM43
	MIMO4X4	FA1A2BFB1A2BM44
	MIMO1X8	FA1A2BFB1A2BM18
	MIMO8X1	FA1A2BFB1A2BM81
	MIMO2X8	FA1A2BFB1A2BM28
	MIMO8X2	FA1A2BFB1A2BM82
	MIMO2X1	FA1A2BFB1A2BM21
	MIMO2X1X2	FA1A2BFB1A2BM212
	MIMO2X2X1	FA1A2BFB1A2BM221
	MIMO2X2X2	FA1A2BFB1A2BM222
	MIMO2X1X3	FA1A2BFB1A2BM213
	MIMO2X1X4	FA1A2BFB1A2BM214
	MIMO2X2X3	FA1A2BFB1A2BM223
	MIMO2X3X1	FA1A2BFB1A2BM231
	MIMO2X3X2	FA1A2BFB1A2BM232
	MIMO2X4X1	FA1A2BFB1A2BM241

:SCONfiguration:MODE	:SCONfiguration:FADing <FadConfig>	[:SOURce<hw>]:FSIMulator:ROUTe
	MIMO3X1X2	FA1A2BFB1A2BM312
	MIMO3X2X1	FA1A2BFB1A2BM321
	MIMO3X2X2	FA1A2BFB1A2BM322
	MIMO4X1X2	FA1A2BFB1A2BM412
	MIMO4X2X1	FA1A2BFB1A2BM421
	MIMO4X2X2	FA1A2BFB1A2BM422
	SISO3X1X1	FAAFBB311
	SISO4X1X1	FAAFBB411
	SISO5X1X1	FAAFBB511
	SISO6X1X1	FAAFBB611
	SISO7X1X1	FAAFBB711
	SISO8X1X1	FAAFBB811
	MIMO2X2X4	FA1A2BFB1A2BM224
	MIMO2X4X2	FA1A2BFB1A2BM242

Parameters:

<Route> FAA | FAMAXAB | FAAFBA | FAAFBB | FABFBB | FBMAXAB | FAABFBAB | FA1A2BFB1A2B | FA1A2BFB1A2BM22 | FA1A2BFB1A2BM24 | FA1A2BFB1A2BM42 | FA1A2BFB1A2BM23 | FA1A2BFB1A2BM32 | FA1A2BFB1A2BM12 | FA1A2BFB1A2BM33 | FA1A2BFB1A2BM34 | FA1A2BFB1A2BM43 | FA1A2BFB1A2BM44 | FA1A2BFB1A2BM18 | FA1A2BFB1A2BM81 | FA1A2BFB1A2BM28 | FA1A2BFB1A2BM82 | FA1A2BFB1A2BM21 | FA1A2BFB1A2BM212 | FA1A2BFB1A2BM221 | FA1A2BFB1A2BM222 | FA1A2BFB1A2BM13 | FA1A2BFB1A2BM31 | FA1A2BFB1A2BM14 | FA1A2BFB1A2BM41 | FAMAXA | FA1A2BFB1A2BM224 | FA1A2BFB1A2BM242 | FA1A2BFB1A2BM312 | FA1A2BFB1A2BM321 | FA1A2BFB1A2BM322 | FA1A2BFB1A2BM412 | FA1A2BFB1A2BM421 | FA1A2BFB1A2BM422 | FAAFBB311 | FAAFBB411 | FAAFBB511 | FAAFBB611 | FAAFBB711 | FAAFBB811 | FA1A2BFB1A2BM213 | FA1A2BFB1A2BM214 | FA1A2BFB1A2BM223 | FA1A2BFB1A2BM231 | FA1A2BFB1A2BM232 | FA1A2BFB1A2BM241 |

FAA
The faded modulation signal of fader A is placed on baseband path A.

FAAFBB
The faded modulation signal of fader A is placed on baseband path A and the faded modulation signal of fader B is placed on baseband path B.

FAAFBA
The faded modulation signal of fader A and B is placed on baseband path A.

FABFBB
The faded modulation signal of fader A and B is placed on baseband path B.

FAABFBAB
The faded modulation signal of fader A and B is placed on baseband paths A and B.

FAMAXA
The faded modulation signal of fader A is placed on baseband path A.

FBMAXB
The faded modulation signal of fader B is placed on baseband path B.

FAMAXAB
The faded modulation signal of fader A is placed on baseband paths A and B.

FBMAXAB

The faded modulation signal of fader B is placed on baseband paths A and B.

FA1A2BFB1A2B|FA1A2BFB1A2BM22| ... |FAAFBB811
sets a MIMO mode

Example: `FSIM:ROUT FA1A2BFB1A2BM24`
selects a 1x2X4 MIMO configuration

Options: LxMxN configurations with L > 2 require option R&S SMW-K76
higher order MIMO configurations require option R&S SMW-K75

Manual operation: See "Signal Routing" on page 81

[:SOURce<hw>]:FSIMulator:SDEStination <SDestination>

Defines the frequency to that the signal of the whole Fader block is dedicated.

Parameters:

<SDestination> RF | BB

RF
The Doppler shift is calculated based on the actual RF frequency, that is *dynamically estimated*.
To query the estimated dedicated frequency, use the command `[:SOURce<hw>]:FSIMulator:FREQuency`.
To query the output connector, use the command `[:SOURce<hw>]:FSIMulator:FREQuency:DETect?` on page 128.

BB
Set the fader frequency *manually* by means of the command `[:SOURce<hw>]:FSIMulator:FREQuency`.

*RST: RF

Example: see `[:SOURce<hw>]:FSIMulator:FREQuency` on page 121

Manual operation: See "Signal Dedicated To" on page 29

[:SOURce<hw>]:FSIMulator:FREQuency:DETect?

Queries the output interface the steam used to estimate the dedicated frequency is mapped to.

Return values:

<DetectMaster> RFA | BBMM1 | RFB | BBMM2 | IQOUT1 | IQOUT2 | FAD1 | FAD2 | FAD4 | FAD3 | DEF

Example: `:SOURce1:FSIMulator:FREQ:DETect?`

Usage: Query only

Manual operation: See "Dedicated Connector" on page 32

[:SOURce<hw>]:FSIMulator:SPEed:UNIT <Unit>

This command chooses the default unit for the parameter speed as displayed in the dialog.

Note: The remote control command changes only the units displayed in the graphical user interface. While configuring the speed via remote control, the speed units must be specified.

Parameters:

<Unit> MPS | KMH | MPH | NMPH

*RST: KMH

Example: `FSIM:SPE:UNIT MPS`
sets meters per second as the default unit for the speed parameter as displayed in the graphical user interface.

Manual operation: See "Speed Unit" on page 42

[:SOURce<hw>]:FSIMulator:STANdard <Standard>

Selects a predefined fading simulator setting which complies with the test specifications found in the common mobile radio standards.

For a detailed summary of all of the default settings, see chapter A, "Predefined Fading Settings", on page 188.

Standard / Test Case	<Predefined_Standard>	Description
-	USER	USER parameter cannot be set. A query returns this value if a user-defined Fading setting was loaded or if one of the associated settings was changed subsequent to the selection of a standard
CDMA see chapter A.1, "CDMA Standards", on page 188	CDMA0 | CDMA3 | CDMA8 | CDMA30 | C1DMA30 | CDMA100	CDMA 5 (0 km/h), CDMA6 (3km/h), CDMA1 (8 km/h), CDMA2 (30 km/h), CDMA3 (30 km/h, 1 path), CDMA4 (100km/h)
GSM see chapter A.2, "GSM Standards", on page 191	GTU1P5 | G6TU1P5 | GTU3P6 | G6TU3P6 | GTU3 | G6TU3 | GTU6 | G6TU6 | GTU50 | G6TU50 | G6TU100 | G6TU60	GSM Typical Urban 1,5/3/3,6/6/50/60/100 km/h, 6 and 12 path
	GHT100 | G6HT100 | GHT120 | G6HT120 | GHT200 | G6HT200	GSM Hilly Terrain 100/120 km/h, 6 and 12 path
	GRA130 | GRA250 | GRA300 | GRA500	GSM Rural Area 130/250/300/500 km/h, 6 path
	GET50 | GET60 | GET100	GSM Equal Test 50/60/100 km/h, 6 path
	GTI5	GSM typical case for very small cells, 5km/h, 2 path

Standard / Test Case	<Predefined_Standard>	Description
NADC see chapter A.3, "NADC Standards", on page 196	NADC8 | NADC50 | NADC100	NADC 8/50/100 km/h, 2 path
DCS1800/PCS1900 see chapter A.4, "PCN Standards", on page 197	P6TU1 | PTU1 | P6TU50 | PTU50	Typical Urban 1/50m´km/h, 6 and 12 path
	P6HT100 | PHT100	Hilly Terrain 100 km/h, 6 and 12 path
	PRA130	Rural Area 130 km/h, 6 path.
	PET50 | PET100	Equal Test 50/100 km/h, 6 path
TETRA see chapter A.5, "TETRA Standards", on page 202	TTU | T6TU	TETRA Typical Urban 50km/h, 2 path and 6 path
	TBU	TETRA 2 path
	THT | T6HT	TETRA Hilly Terrain 200 km/h, 2 path and 6 path
	T4ET	TETRA Equal Test 200 km/h, 4 path
	TDU	TETRA Mode Direct Mode Rural Propagation Model 1 path
	TDR	TETRA Mode Urban Propagation Mode 1 path
3GPP FDD see chapter A.6, "3GPP Standards", on page 206	G3C1 | G3C2 | G3C3 | G3C4	3GPP FDD Test Case x (BS)
	G3UEC1 | G3UEC2 | G3UEC3 | G3UEC4 | G3UEC5 | G3UEC6	3GPP FDD UE Test Case x (UE)
	G3UEC7SE	3GPP FDD UE Sector (UE)
	G3UEC7BE	3GPP FDD Beam (UE)
	G3UEC8CQ	3GPP FDD CQI (UE)
	G3UEPA3 | G3UEPB3	3GPP FDD Pedestrian A 4 path / B 6 path (UE)
	G3UEVA3 | G3UEVA30 | G3UEVA120	3GPP FDD Vehicular A 6 path (UE)
	G3MBSFN3	3GPP MBSFN
	G3TU3 | G3TU50 | G3TU120	3GPP FDD Typical Urban 20 path
	G3HT120	3GPP FDD Hilly Terrain 20 path

Standard / Test Case	<Predefined_Standard>	Description
	G3RA120 | G3RA250	3GPP FDD Rural Area 10 path
	BD1	3GPP Birth Death 2 path
Moving Propagation see chapter A.15, "3GPP/LTE Moving Propagation", on page 252	MD1	3GPP Moving Propagation "Ref. + Moving Channel", 2path
	MPLTEETU200	3GPP Moving Propagation scenario 1 "ETU200Hz", according to the test case 3GPP TS36.141, annex B4.
	MPLTEPDOPP	3GPP Moving Propagation scenario 2 "AWGN", according to the test case 3GPP TS36.141, annex B4.
3GPP High Speed Train scenarios see chapter A.14, "3GPP/LTE High Speed Train", on page 250	G3HST1OS | G3HST1OSDU	3GPP HST1 "Open space", according to the test case 3GPP TS25.141, annex D.4A and 3GPP TS36.141, annex B.3
	G3HST2TLC | G3HST2TLCDU	3GPP HST2 "Tunnel with leaky cable", according to the test case 3GPP TS25.141, annex D.4A
	G3HST3TMA | G3HST3TMADU	3GPP HST3 "Tunnel for multi-antennas", according to the test case 3GPP TS25.141, annex D.4A and 3GPP TS36.141, annex B.3
SCME UMi 3kmh/30kmh SCME UMa 3kmh/30kmh see chapter A.16, "SCME Channel Models for MIMO OTA", on page 254	G3SCMEUMA3 | G3SCMEUMA30 | G3SCMEUMI3 | G3SCMEUMI30	SCME Urban Micro/Macro-Cell Channel, 3 km/h and 30 km/h
WLAN see chapter A.7, "WLAN Standards", on page 217	HL2A | HL2B | HL2C | HL2D | HL2E	WLAN HyperLan 18 path
DAB see chapter A.8, "DAB Standards", on page 222	DABRA04 | DABRA06	DAB Rural Area 4 and 6 path
	DABTU12 | DABTU06	DAB Typical Urban 12 and 6 path
	DABSFN	DAB Single Frequency Network (in the VHF range) 7 path
WiMAX	WMITUOIPA | WMITUOIPB | WMITUVA60 | WMITUVA120	Wimax ITU OIP-A, ITU OIP-B, ITU V-A-60, ITU V-A-120

Standard / Test Case	<Predefined_Standard>	Description
see chapter A.9, "WIMAX Standards", on page 224	WMSUI1A360P90 | WMSUI1A360P75 | WMSUI1A030P90 | WMSUI1A030P75	SUI 1 (omi ant. 90/75%), SUI 1 (30 ant. 90/75%)
	WMSUI2A360P90 | WMSUI2A360P75 | WMSUI2A030P90 | WMSUI2A030P75	SUI 2 (omi ant. 90/75%), SUI 2 (30 ant. 90/75%)
	WMSUI3A360P90 | WMSUI3A360P75 | WMSUI3A030P90 | WMSUI3A030P75	SUI 3 (omi ant. 90/75%), SUI 3 (30 ant. 90/75%)
	WMSUI4A360P90 | WMSUI4A360P75 | WMSUI4A030P90 | WMSUI4A030P75	SUI 4 (omi ant. 90/75%), SUI 4 (30 ant. 90/75%)
	WMSUI5A360P90 | WMSUI5A360P75 | WMSUI5A360P50 | WMSUI5A030P90 | WMSUI5A030P75 | WMSUI5A030P50	SUI 5 (omi ant. 90/75/50%), SUI 5 (30 ant. 90/75/50%)
	WMSUI6A360P90 | WMSUI6A360P75 | WMSUI6A360P50 | WMSUI6A030P90 | WMSUI6A030P75 | WMSUI6A030P50 |	SUI 6 (omi ant. 90/75/50%), SUI 6 (30 ant. 90/75/50%)
WiMAX-MIMO see chapter A.12, "WIMAX-MIMO Standards", on page 242	WMITUPB3L | WMITUPB3M | WMITUPB3H | WMITUVA60L | WMITUVA60M | WMITUVA60H	ITU PB Low/Medium/High, ITU VA Low/Medium/High
LTE see chapter A.10, "LTE Standards", on page 237	LTEEPA5 | LTEEVA5 | LTEEVA70 | LTEETU70 | LTEETU300 | LTEMBSFN5	LTE EPA 5Hz , LTE EVA 5/70Hz, LTE ETU 70/300Hz, LTE MBSFN 5Hz
LTE-MIMO see chapter A.11, "LTE-MIMO Standards", on page 240	LMEPA5L | LMEPA5M | LMEPA5H | LMEVA5L | LMEVA5M | LMEVA5H | LMEVA70L | LMEVA70M | LMEVA70H | LMETU70L | LMETU70M | LMETU70H | LMETU300L | LMETU300M | LMETU300H	LTE EPA 5Hz Low/Medium/High, LTE EVA 5/70Hz Low/Medium/High, LTE ETU 70/300Hz Low/Medium/High
1xEVDO see chapter A.13, "1xEVDO Standards", on page 246	EVDO1CH1 | EVDO1CH1BC5 | EVDO1CH2 | EVDO1CH2BC5 | EVDO1CH3 | EVDO1CH3BC5 | EVDO1CH4 | EVDO1CH4BC5 | EVDO1CH5 | EVDO1CH5BC5	1xEVDO Chan. 1/2/3/4/5
WATTERSON see chapter A.17, "Watterson Standards", on page 256	WATTI1 | WATTI3 | WATTI2	Watterson I1, I2, I3

Standard / Test Case	<Predefined_Standard>	Description
802.11n-SISO see chapter A.18, "802.11n-SISO Standards", on page 258	WLANNSMODA | WLANNSMODB | WLANNSMODC | WLANNSMODD | WLANNSMODE | WLANNSMODF	802.11n SISO Model A/B/C/D/E/F
802.11n-MIMO see chapter A.19, "802.11n-MIMO Standards", on page 258	WLANNMODA | WLANNMODB | WLANNMODC | WLANNMODD | WLANNMODE | WLANNMODF	802.11n MIMO Model A/B/C/D/E/F
802.11ac-SISO see chapter A.21, "802.11ac-SISO Standards", on page 279	WLANACSMODA|WLANACSMODB| WLANACSMODC|WLANACSMODD| WLANACSMODE|WLANACSMODF	802.11ac SISO Model A/B/C/D/E/F
802.11ac-MIMO see chapter A.20, "802.11ac-MIMO Standards", on page 269	WLANACMODA | WLANACMODB | WLANACMODC | WLANACMODD | WLANACMODE | WLANACMODF	802.11ac MIMO Model A/B/C/D/E/F
802.11p see chapter A.22, "802.11p Channel Models", on page 280	WLANPRURALLOS | WLANPURBANAPPLOS | WLANPURBANCRONLOS | WLANPHIGHWAYNLOS | WLANPHIGHWAYLOS	802.11p Channel models: Rural LOS, Urban Approaching LOS, Urban Crossing NLOS, Highway LOS, Highway NLOS

Parameters:

<Standard>

USER | CDMA8 | CDMA30 | C1DMA30 | CDMA100 | CDMA0 | CDMA3 | G6TU3 | GTU3 | G6TU50 | GTU50 | G6HT100 | GHT100 | GRA250 | GET50 | GET100 | HL2A | HL2B | HL2C | HL2D | HL2E | NADC8 | NADC50 | NADC100 | P6TU1 | PTU1 | P6TU50 | PTU50 | P6HT100 | PHT100 | PRA130 | PET50 | PET100 | TTU | TBU | THT | T4ET | G3C1 | G3C2 | G3C3 | G3C4 | G3UEC4 | G3UEC5 | G3UEC6 | G3UEC7SE | G3UEC7BE | G3UEC8CQ | G3UEPA3 | G3UEPB3 | G3UEVA30 | G3UEVA120 | G3TU3 | G3TU50 | G3TU120 | G3HT120 | G3RA120 | G3RA250 | BD1 | MP1 | DABRA04 | DABRA06 | DABTU12 | DABTU06 | DABSFN | WMSUI1A360P90 | WMSUI1A360P75 | WMSUI1A030P90 | WMSUI1A030P75 | WMSUI2A360P90 | WMSUI2A360P75 | WMSUI2A030P90 | WMSUI2A030P75 | WMSUI3A360P90 | WMSUI3A360P75 | WMSUI3A030P90 | WMSUI3A030P75 | WMSUI4A360P90 | WMSUI4A360P75 | WMSUI4A030P90 | WMSUI4A030P75 | WMSUI5A360P90 | WMSUI5A360P75 | WMSUI5A360P50 | WMSUI5A030P90 | WMSUI5A030P75 | WMSUI5A030P50 | WMSUI6A360P90 | WMSUI6A360P75 | WMSUI6A360P50 | WMSUI6A030P90 | WMSUI6A030P75 | WMSUI6A030P50 | WMITUOIPA | WMITUOIPB | WMITUVA60 | TDU | TDR | WMITUVA120 | GET60 | G6HT120 | G6HT200 | GRA130 | GRA300 | GRA500 | G6TU1P5 | G6TU3P6 | G6TU6 | G6TU60 | G6TU100 | GHT120 | GHT200 | GTU1P5 | GTU3P6 | GTU6 | GTU60 | GTU100 | LMEPA5L | LMEPA5M | LMEPA5H | LMEVA5L | LMEVA5M | LMEVA5H | LMEVA70L | LMEVA70M | LMEVA70H | LMETU70L | LMETU70M | LMETU70H | LMETU300L | LMETU300M | LMETU300H | WMITUPB3L | WMITUPB3M | WMITUPB3H | WMITUVA60L | WMITUVA60M | WMITUVA60H | EVDO1CH1 | EVDO1CH1BC5 | EVDO1CH2 | EVDO1CH2BC5 | EVDO1CH3 | EVDO1CH3BC5 | EVDO1CH4 | EVDO1CH4BC5 | EVDO1CH5 | EVDO1CH5BC5 | G3HST1OS | G3HST2TLC | G3HST3TMA | MPLTEETU200 | MPLTEPDOPP | T6TU | T6HT | LTEEPA5 | LTEEVA5 | LTEEVA70 | LTEETU70 | LTEETU300 | G3UEC1 | G3UEC2 | G3UEC3 | G3UEVA3 | G3MBSFN3 | WATTI1 | WATTI3 | WATTI2 | GTI5 | G3HST1OSDU | G3HST2TLCDU | G3HST3TMADU | LTEMBSFN5 | LTECQI5 | LTEETU30 | LMETU30L | LMETU30M | LMETU30H | WLANNMODA | WLANNMODB | WLANNMODC | WLANNMODD | WLANNMODE | WLANNMODF | WLANACMODA | WLANACMODB | WLANACMODC | WLANACMODD | WLANACMODE | WLANACMODF | WLANNSMODA | WLANNSMODB | WLANNSMODC | WLANNSMODD | WLANNSMODE | WLANNSMODF | WLANACSMODA | WLANACSMODB | WLANACSMODC | WLANACSMODD | WLANACSMODE | WLANACSMODF | G3SCMEUMA3 | G3SCMEUMA30 | G3SCMEUMI3 | G3SCMEUMI30 | WLANPRURALLOS |

WLANPURBANAPPLOS | WLANPURBANCRONLOS | WLANPHIGHWAYNLOS | WLANPHIGHWAYLOS

*RST: USER

Example: `FSIM:STAN THT`
selects settings in conformity with Tetra Hilly Terrain 200 (with two fading paths).

Manual operation: See "Standard / Test Case" on page 27

[:SOURce<hw>]:FSIMulator:STANdard:REFerence <Reference>

Queries the reference in the standard for the selected test case.

Parameters:
<Reference> string

Example: `FSIM:STAN WC1BUP2`
selects settings in conformity with 3GPP FDD Test Case 1 (with two fading paths).
`FSIM:STAN:REF?`
queries the reference in the standard.
`Response: "3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2"`
the test case is defined in the specified reference.

Manual operation: See "Standard / Test Case" on page 27

[:SOURce<hw>]:FSIMulator:SUM:RATio <Ratio>

Set the ratio of the output levels of both paths A and B in case the fader 1 and 2 are added.

A positive value of the parameter Summation Ration A/B indicates a stronger signal on path A; respectively a negative value indicates a stronger signal on path B.

Parameters:
<Ratio> float

Range: -80 to 80
Increment: 0.1
*RST: 0

Example: `FSIM:SUM:RAT -30`
sets the ratio to -30dB.

[:SOURce<hw>]:FSIMulator[:STATe] <State>

This command activates fading simulation.

Parameters:
<State> 0 | 1 | OFF | ON

*RST: 0

Example: `FSIM ON`
activates fading simulation in baseband path A with the current settings.

Manual operation: See "State" on page 25
See "State Path" on page 44

[:SOURce]:FSIMulator:CATalog?

Reads out the files with fading settings in the default directory. The default directory is set with the command `MMEM:CDIRectory`. Only files with the file ending `*.fad` are read out.

Return values:
<FileNames> string

Example: `MMEM:CDIR "/var/user/fading"`
sets the default directory
`FSIM:STOR "delay_3gpp"`
saves the current fading simulator settings of fader A in the file `delay_3gpp`.
`FSIM:CAT?`
reads all files from the default directory with fading settings
Response: `Birth_3gpp, delay_3gpp, fad_test`
`FSIM:LOAD "Birth_3gpp"`
loads the fading settings from the file `Birth_3gpp`.
`FSIM:DELETE "fad_test"`
deletes the file `fad_test`.

Usage: Query only

Manual operation: See "Save/Recall" on page 26

[:SOURce<hw>]:FSIMulator:LOAD <Filename>

Loads the specified file containing a fading setting from the default directory. The default directory is set with the command `MMEM:CDIRectory`. A path can also be specified. Only files with the file ending `*.fad` are loaded.

Setting parameters:
<Filename> string

Example: see `[:SOURce]:FSIMulator:CATalog?` on page 136

Usage: Setting only

Manual operation: See "Save/Recall" on page 26

[:SOURce]:FSIMulator:DELETE <Filename>

Deletes the specified file containing a fading setting from the default directory. The default directory is set with the command `MMEM:CDIRectory`. A path can also be specified. Only files with the file ending `*.fad` are deleted.

Note: This command is only valid with DELETE in the long form as DEL is used as short form of header keyword DELay.

Setting parameters:
<Filename> string

Example: see `[:SOURce]:FSIMulator:CATalog?` on page 136

Usage: Setting only

Manual operation: See "Save/Recall" on page 26

[:SOURce<hw>]:FSIMulator:STORe <Filename>

Saves the current fading simulator settings in the specified file in the default directory. The default directory is set with the command `MMEM:CDIRectory`. A path can also be specified. The file ending `*.fad` is automatically used.

Setting parameters:
<Filename> string

Example: see `[:SOURce]:FSIMulator:CATalog?` on page 136

Usage: Setting only

Manual operation: See "Save/Recall" on page 26

[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:CSTD <Cstd>
[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:LCONstant <LConstant>

(available in "System Configuration > Mode > Standard")

Couples the lognormal fading setting.

Parameters:
<LConstant> 0 | 1 | OFF | ON
*RST: 0

Example:

```
SCONfiguration:MODE STANdard

SOURce1:FSIMulator:CONFiguration STAN
SOURce1:FSIMulator:DEL:GROup1:PATH1:PROFile PDOP
SOURce1:FSIMulator:DEL:GROup1:PATH1:SPEed 1111.111
SOURce1:FSIMulator:STATe 1
SOURce1:FSIMulator:COUPle:SPEed 1
SOURce1:FSIMulator:CSPeed 1

SOURce2:FSIMulator:CONFiguration STAN
SOURce2:FSIMulator:STATe 1
SOURce2:FSIMulator:DEL:GROup1:PATH1:SPEed?
// 1111.111

SOURce1:FSIMulator:COUPle:LOGNormal:LCONstant 1
SOURce1:FSIMulator:COUPle:LOGNormal:CSTD 1
SOURce1:FSIMulator:DEL:GROup1:PATH1:LOGNormal:STATe 1
SOURce1:FSIMulator:DEL:GROup1:PATH1:LOGNormal:LCONstant 150
SOURce2:FSIMulator:DEL:GROup1:PATH1:LOGNormal:LCONstant?
// 150
SOURce1:FSIMulator:DEL:GROup1:PATH1:LOGNormal:CSTD 2
SOURce2:FSIMulator:DEL:GROup1:PATH1:LOGNormal:CSTD?
// 2
```

Manual operation: See "Local Constant Coupled" on page 39

[:SOURce<hw>]:FSIMulator:COUPle:SPEed <Speed>

(available in "System Configuration > Mode > Standard")

Couples the setting for the speed for the paths of both faders.

Parameters:

<Speed> 0 | 1 | OFF | ON
*RST: 0

Example: see `[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:LCONstant` on page 137

Manual operation: See "Speed Setting Coupled" on page 39

[:SOURce<hw>]:FSIMulator:CSPeed <CSpeed>

Determines whether the same speed is set for all of the activated fading paths.

Parameters:

<CSpeed> 0 | 1 | OFF | ON
*RST: 1

Example: see `[:SOURce<hw>]:FSIMulator:COUPle:LOGNormal:LCONstant` on page 137

Manual operation: See "Common Speed For All Paths" on page 43

8.2 Birth Death

The Birth Death dynamic fading configurations are available with option R&S SMW-K71.

[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:GRID 139
[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:MINimum 139
[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:MAXimum? 139
[:SOURce<hw>]:FSIMulator:BIRThdeath:HOPPing:DWELl 140
[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:LOSS 140
[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:PROFile 140
[:SOURce<hw>]:FSIMulator:BIRThdeath:POSitions 141
[:SOURce<hw>]:FSIMulator:BIRThdeath:SOFFset 141
[:SOURce<hw>]:FSIMulator:BIRThdeath:SPEed 141
[:SOURce<hw>]:FSIMulator:BIRThdeath:FRATio 142
[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:FDOPpler? 142
[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:FDOPpler:ACTual? 143
[:SOURce<hw>]:FSIMulator:BIRThdeath:STATe 143

[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:GRID <Grid>

Sets the delay grid for both paths with birth death propagation fading.

Parameters:

<Grid> float

Range: 1E-9 to dynamic
Increment: 1E-9
*RST: 1E-6

Example: `FSIM:BIRT:DEL:GRID 0.00001`
sets a delay grid of 10 us.

Manual operation: See "Delay Grid" on page 55

[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:MINimum <Minimum>
[:SOURce<hw>]:FSIMulator:BIRThdeath:DELay:MAXimum?

Queries the minimum/maximum delay for both paths with birth death propagation fading.

Return values:

<Maximum> float

Range: 0 to max

Example: `FSIM:BIRT:DEL:MIN 0.000012`
sets a minimum delay of 12 us.
`FSIM:BIRT:DEL:GRID 0.000002`
sets a delay grid of 2 us.
`FSIM:BIRT:POS 9`
sets 9 possible hop positions.
`FSIM:BIRT:DEL:MAX?`
queries the maximum delay.
`Response: 0.000028`
the maximum delay is 28 us. The delay range lies between +12 and +28 us. There are 9 hop positions on a 2 us grid available.

Usage: Query only

Manual operation: See "Maximum Delay" on page 55

[:SOURce<hw>]:FSIMulator:BIRThdeath:HOPPing:DWELl <Dwell>

Sets the time until the next change in the delay of a path (birth death event).

Parameters:

<Dwell> float

Range: 1E-3 to 429.49672950
Increment: 100E-9
*RST: 191E-3

Example: `FSIM:BIRT:HOPP:DWEL 210 ms`
sets a dwell time of 210 ms until the next change in the delay of a fading path.

Manual operation: See "Hopping Dwell" on page 56

[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:LOSS <Loss>

Sets the loss of the paths with birth death propagation.

Parameters:

<Loss> float

Range: 0 to 50
Increment: 0.001
*RST: 0
Default unit: dB

Example: `FSIM:BIRT:PATH2:LOSS 4 dB`
sets a loss of 4 dB for the second fading path.

Manual operation: See "Path Loss" on page 54

[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:PROFile <Profile>

This command queries the fading profile. In birth death propagation, the pure Doppler profile is used.

Parameters:

<Profile> PDOPpler

*RST: PDOPpler

Example: `FSIM:BIRT:PATH2:PROF?`
queries the profile of the second fading path.

Manual operation: See "Profile" on page 54

[:SOURce<hw>]:FSIMulator:BIRThdeath:POSitions <Positions>

Sets the number of possible hop positions in the delay range.

0 us < (. . . :BIRT:POS – 1) x . . . :DEL:GRID + . . . :DEL:MIN < 40 us

Parameters:

<Positions> integer

Range: 3 to 50
*RST: 11

Example: `FSIM:BIRT:POS 11`
sets 11 possible delay positions.

Manual operation: See "Positions" on page 55

[:SOURce<hw>]:FSIMulator:BIRThdeath:SOFFset <Soffset>

Sets the time until the start of the next birth death event. With dual-channel fading, this allows the user to intentionally displace the birth death events of the two faders with respect to one another.

Parameters:

<Soffset> float

Range: 0 to 429
Increment: 100E-9
*RST: 0

Example: `FSIM:BIRT:SOFF 21E-6`
sets a start offset of 21 us.

Manual operation: See "Start Offset" on page 55

[:SOURce<hw>]:FSIMulator:BIRThdeath:SPEed <Speed>

Sets the speed of the moving receiver for birth death propagation.

The default speed unit is m/s. Units different than the default one must be specified.

Parameters:

<Speed> float

Range: 0 to dynamic
Increment: 0.001
*RST: 0
Default unit: m/s

Example:

```
SOURce1:FSIMulator:BIRThdeath:SPEed 100 KMH
SOURce1:FSIMulator:BIRThdeath:PATH1:FDOPpler?
// 92.6574343641427
SOURce1:FSIMulator:BIRThdeath:FRATio 1
SOURce1:FSIMulator:BIRThdeath:PATH1:FDOPpler:ACTual?
// 92.66
SOURce1:FSIMulator:BIRThdeath:FRATio 0.5
SOURce1:FSIMulator:BIRThdeath:PATH1:FDOPpler:ACTual?
// 46.33
```

Manual operation: See "Speed" on page 57

[:SOURce<hw>]:FSIMulator:BIRThdeath:FRATio <FRatio>

Sets the ratio of the actual Doppler frequency to the set Doppler frequency with birth death propagation fading.

Parameters:

<FRatio> float

Range: -1 to 1
Increment: 0.0001
*RST: 1

Example: see `[:SOURce<hw>]:FSIMulator:BIRThdeath:SPEed` on page 141

Manual operation: See "Frequency Ratio" on page 57

[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:FDOPpler?

Queries the resulting Doppler frequency with birth death propagation.

Return values:

<FDoppler> float

Range: 0 to 1000
Increment: 0.01
*RST: 0

Example: see `[:SOURce<hw>]:FSIMulator:BIRThdeath:SPEed` on page 141

Usage: Query only

Manual operation: See "Resulting Doppler Shift" on page 57

[:SOURce<hw>]:FSIMulator:BIRThdeath:PATH<ch>:FDOPpler:ACTual?

Queries the actuial Doppler frequency.

Return values:

<ActDoppler> float
Range: -1600 to 1600
Increment: 0.01
*RST: 0

Example: see `[:SOURce<hw>]:FSIMulator:BIRThdeath:SPEed` on page 141

Usage: Query only

Manual operation: See "Actual Doppler Shift" on page 57

[:SOURce<hw>]:FSIMulator:BIRThdeath:STATe <State>

This command selects the birth death propagation fading configuration and switches the fading simulation on and off.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: 0

Example:
```
SOUR2:FSIM:BIRT:STAT ON
```
selects birth death propagation for fader B and switches on fading in path B.

Manual operation: See "Configuration" on page 27

8.3 Delay Modes

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:ADELay 144
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:ADELay 144
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:BDELay 144
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:BDELay 144
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:COEFficient 145
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:PHASe 145
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:STATe 146
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CPHase 146
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:FDOPpler 147
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler[:RESulting] 147
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler:ACTual? 147
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:FRATio 148
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FRATio 148
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FSHift 148
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FSPRead 149
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:CSTD 149

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:LCONstant.... 149
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:STATe..... 150
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:LOSS.....150
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOSS.....150
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PRATio..... 150
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:PROFile.....151
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PROFile..... 151
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:RDELay?..... 152
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:RDELay?.....152
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:SPEed..... 152
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:SPEed..... 152
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:STATe..... 153
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:STATe..... 153
[:SOURce<hw>]:FSIMulator:DELay|DEL:STATe..... 153

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:ADELay
<ADelay>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:ADELay
<ADelay>

Determines the path-specific delay ("Additional Delay") of the selected path. The Resulting Delay of a path is obtained by adding the Basic Delay and the Additional Delay.

Parameters:

<ADelay> float

Range: 0 to 40.0E-6 s
*RST: 0

Example: `FSIM:DEL:STAT ON`
activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO:PATH2:ADEL 10E-6`
sets an Additional Delay of 10 us for fading path 2.

Manual operation: See "Additional Delay" on page 46

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:BDELay
<BDelay>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:BDELay
<BDelay>

Determines the group delay ("Basic Delay". Within a group, all of the paths are jointly delayed by this value. The Resulting Delay of a path is obtained by adding the Basic Delay and the Additional Delay. The Basic Delay of group 1 is always equal to 0.

Parameters:

<BDelay> float

Range: 0.0 to 2.56E-3 s
Increment: 10 ns
*RST: 0.0

Example: `FSIM:DEL:STAT ON`
activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO2:PATH:BDEL 1E-3`
sets a delay of 1 ms for fading group 2. This value applies to all of the paths in the group.

Manual operation: See "Basic Delay" on page 46

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:COEFficient <Coefficient>

Determines the magnitude of the complex correlation coefficient. The higher the entered percentage, the greater the correlation of the statistical fading processes for the two paths. Highly correlated ambient conditions for the signal are simulated in this manner.

Sets the correlation coefficient of the correlated path of the second fader also to the entered value.

Parameters:
<Coefficient> float

Range: 0 to 100
Increment: 0.1
*RST: 100
Default unit: PCT

Example: `FSIM:DEL:STAT ON`
activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO2:PATH:CORR:STAT ON`
switches on the correlation of fading path 1 of group 2 of fader A to fading path 1 of group 2 of fader B.
`FSIM:DEL:GRO2:PATH:CORR:COEF 95`
specifies a correlation coefficient of 95% for the two paths.

Manual operation: See "Correlation Coefficient" on page 49

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:PHASe <Phase>

Determines the phase of the complex correlation coefficient.

Sets the phase of the correlation coefficient of the correlated path of the second fader also to the entered value.

Parameters:
<Phase> float

Range: 0 to 359.9
Increment: 0.05
*RST: 0
Default unit: DEG

Example: `FSIM:DEL:STAT ON`
activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO2:PATH:CORR:STAT ON`
switches on the correlation of fading path 1 of group 2 of fader A to fading path 1 of group 2 of fader B.
`FSIM:DEL:GRO2:PATH:CORR:PHAS 5`
specifies a phase of the correlation coefficient equal to 5 DEG for the two paths.

Manual operation: See "Correlation Coefficient Phase" on page 50

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CORRelation:STATe <State>

Enables correlation of the paths of the first fader. The suffix in `SOURce` defines the fader on which path settings the correlation is based.

When correlation is activated, the settings of the correlation parameters, the profile, the speed and the lognormal parameters are the same for both paths.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: 0

Example:
```
SOURce1:FSIMulator:DELay:STATe ON
SOURce1:FSIMulator:DELay:GROup2:PATH1:
CORRelation:STATe ON
```
enables correlation of fading path 1 of group 2 of fader A to fading path 1 of group 2 of fader B.

Manual operation: See "Correlation Path" on page 49

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CPHase <CPhase>

Sets the start phase rotation.

Parameters:

<CPhase> float
Range: 0 to 359.9
Increment: 0.1
*RST: 0
Default unit: DEG

Example: `FSIM:DEL:STAT ON`
activates the Standard Delay fading configuration.
`FSIM:DEL:GRO1:PATH1:PROF RICE`
selects the Rice fading profile for fading path 1 of group 1.
`FSIM:DEL:GRO1:PATH:CPH 5DEG`
sets a start phase rotation of 5 DEG for fading path 1 of group 2. The path is multiplied by this phase.

Manual operation: See "Const. Phase" on page 47
See "Start Phase" on page 47

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:FDOPpler <FDoppler>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler[:RESulting] <FDoppler>

Queries the resulting Doppler frequency for the fading configuration.

The Doppler frequency is determined by the selected speed ([:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:SPEed).

For the Pure Doppler and Rice Fading profiles, the actual Doppler shift is a function of the selected ratio of the Doppler shift to the Doppler frequency ([:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FRATio). Use the command [:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler:ACTual? to query the actual Doppler shift.

Parameters:

<FDoppler> float

Range: 0 to 4000
Increment: 0.01
*RST: 0

Example:

```
SOURce1:FSIMulator:CONFiguration STAN
SOURce1:FSIMulator:DEL:GROup1:PATH1:PROFile RICE
SOURce1:FSIMulator:DEL:GROup1:PATH1:FRATio 1
SOURce1:FSIMulator:DEL:GROup1:PATH1:FDOPpler:RESulting?
// Response:  2.77968967451476
// set a frequency ratio for the first fading path of group 1.
// I.e. set an angle of incidence of about 45° with respect to
// a receiver that is going away from the transmitter
SOURce1:FSIMulator:DEL:GROup1:PATH1:FRATio -0.71
SOURce1:FSIMulator:DEL:GROup1:PATH1:FDOPpler:RESulting?
// Response:  2.77968967451476
SOURce1:FSIMulator:DELay:GROup1:PATH1:FDOPpler:ACTual?
// Response:  -1.97
```

Manual operation: See "Resulting Doppler Shift" on page 48

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler:ACTual?

Queries the actual Doppler shift.

For the Pure Doppler and Rice Fading profiles, the actual Doppler shift is a function of the selected ratio of the Doppler shift to the Doppler frequency ([:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FRATio).

Return values:

<ActDoppler> float

Range: -4000.0 to 4000
Increment: 0.01
*RST: 0

Example: see `[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler[:RESulting]` on page 147

Usage: Query only

Manual operation: See "Actual Doppler Shift" on page 49

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:FRATio <FRatio>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FRATio <FRatio>

For Rice, pure Doppler and Gauss Doppler fading, sets the ratio of the actual Doppler frequency to the set Doppler frequency. The Frequency Ratio serves as a measure of the angle of incidence between the transmitter and receiver.

Parameters:

<FRatio> float

Range: -1 to 1
Increment: 0.0001
*RST: 0

Example: see `[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FDOPpler[:RESulting]` on page 147

Manual operation: See "Frequency Ratio" on page 48

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FSHift <FShift>

Sets the frequency shift for the Gauss Watterson fading.

Parameters:

<FShift> float

Range: -10 to 10
Increment: 0.0001
*RST: 0

Example:
```
FSIM:DEL:GRO:PATH2:PROF WATT
FSIM:DEL:GRO:PATH2:FS?
```

Manual operation: See "Frequency Shift" on page 47

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:FSPRead <FSpread>

Sets the frequency spread for the Gauss Watterson fading.

Parameters:

<FSpread> float

Range: 1E-4 to 10
Increment: 1E-4
*RST: 0.1

Example:
```
FSIM:DEL:GRO:PATH2:PROF WATT
FSIM:DEL:GRO:PATH2:FSPR?
```

Manual operation: See "Frequency Spread" on page 46

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:CSTD <Cstd>

Sets the standard deviation for lognormal fading.

Parameters:

<Cstd> integer

Range: 0 to 12
*RST: 0
Default unit: dB

Example:
```
FSIM:DEL:STAT ON
```
activates the `Standard Delay` fading configuration.
```
FSIM:DEL:GRO:PATH2:LOGN:STAT ON
```
selects lognormal fading for fading path 2 of group 1.
```
FSIM:DEL:GRO:PATH2:LOGN:CSTD 2
```
sets a standard deviation of 2 dB for fading path 2 of group 1.

Manual operation: See "Standard Deviation " on page 51

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:LCONstant <LConstant>

Sets the Local Constant for lognormal fading.

Parameters:

<LConstant> float

Range: 0 to 200
Increment: 0.1
*RST: 100
Default unit: m

Example: `FSIM:DEL:STAT ON`
activates the Standard Delay fading configuration.
`FSIM:DEL:GRO:PATH2:LOGN:STAT ON`
selects lognormal fading for fading path 2 of group 1.
`FSIM:DEL:GRO:PATH2:LOGN:LCON 100`
sets a Local Constant of 100 m for the second fading path of group 1.

Manual operation: See "Local Constant" on page 50

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOGNormal:STATe <State>

Enables/ disables a lognormal fading.

Parameters:
<State> 0 | 1 | OFF | ON
*RST: 0

Example: `FSIM:DEL:STAT ON`
activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO:PATH2:LOGN:STAT ON`
activates lognormal fading for fading path 2 of group 1.

Manual operation: See "Lognormal State" on page 50

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:LOSS <Loss>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:LOSS <Loss>

Sets the loss of the paths.

Parameters:
<Loss> float
Range: 0 to 50
Increment: 0.001
*RST: 10|0
Default unit: dB

Example: `FSIM:DEL:STAT ON`
activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO:PATH2:LOSS 2 dB`
sets a loss of 2 dB for fading path 2 of group 1.

Manual operation: See "Path Loss" on page 46

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PRATio <PRatio>

Sets the power ratio of the discrete and distributed components for Rice fading (`:SOURce:FSIMulator:DELay:GROup:PATH2:PROFile RICE`).

Parameters:

<PRatio> float

Range: -30 to 30
Increment: 0.01
*RST: 0
Default unit: dB

Example: `FSIM:DEL:STAT ON`
activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO:PATH2:PROF RICE`
sets the Rice fading profile for fading path 2 of group 1.
`FSIM:DEL:GRO:PATH2:PRAT -15`
sets a power ratio of –15 dB. The distributed (Rayleigh) component prevails. The total power of the two components remains constant.

Manual operation: See "Power Ratio" on page 46

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:PROFile
<Profile>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:PROFile
<Profile>

Selects the fading profile for the paths.

Parameters:

<Profile> SPATh | RAYLeigh | PDOPpler | RICE | CPHase | OGAUs | TGAUs | DGAUs | WDOPpler | WRICe | GDOPpler | GFD8 | GFD1 | WATTerson | BELLindoor | BELVehicle

SPAT
static transmission path

PDOPpler | RAYLeigh | RICE
pure Doppler | Rayleigh | Rice

CPHase
constant phase

OGAUs | TGAUs | DGAUs | GDOPpler | GFD8 | GFD1
GAUS1 | GAUS2 | GAUSDAB | Gauss Doppler | Gauss (0.08 f_d) | Gauss (0.01 f_d)

WATTerson
Gauss (Watterson)

WDOPpler | WRICe
WiMAX Doppler | WiMAX Rice

BELLindoor|BELVehicle
Bell Shape tgn Indoor, Bell Shape tgn Moving Vehicle

*RST: RAYLeigh

Manual operation: See "Profile" on page 44

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:RDELay?
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:RDELay?

Queries the Resulting Delay of the paths for the selected fading configuration. The Resulting Delay is the sum of the Basic Delay (`SOURce:FSIM:...:BDELay`) and the Additional Delay (`SOURce:FSIM:...:ADELay`).

Return values:

<RDelay> float

Range: 0 to max
Increment: 10E-9
*RST: 0

Example: `FSIM:DEL:STAT ON`
activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO2:PATH:BDEL 2E-4`
sets a Delay Offset of 200 us for group 2.
`FSIM:DEL:GRO2:PATH2:ADEL 1E-5`
sets an Additional Delay of 10 us for fading path 2 of group 2.
`FSIM:DEL:GRO2:PATH2:RDEL?`
queries the Resulting Delay for fading path 2 of group 2.
`Response: 0.00021`
the Resulting Delay is 210 us.

Usage: Query only

Manual operation: See "Resulting Delay" on page 46

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:SPEed <Speed>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:SPEed <Speed>

Sets the speed v of the moving receiver.

Parameters:

<Speed> float

Range: 0 to dynamic
Increment: 0.001
*RST: 0.83333

Example: `FSIM:DEL:STAT ON`
activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO:PATH2:SPE 2MPS`
sets a speed of 2 m/s for the moving receiver for fading path 2 of group 1.

Manual operation: See "Speed" on page 47

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:STATe <State>
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:STATe <State>

Activates the selected path.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: 0

Example: `FSIM:DEL:STAT ON`
activates the "Standard Delay" fading configuration.
`FSIM:DEL:GRO:PATH2:STAT ON`
activates fading path 2 in group 1.

Manual operation: See "State Path" on page 44

[:SOURce<hw>]:FSIMulator:DELay|DEL:STATe <State>

Activates the fading configurations.

Note: Changing the configuration will cause an interruption in the fading process, followed by a restart after about one second.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: 0

Example: `FSIM:DEL:STAT ON`
activates the "Standard Delay" fading configuration for fader A and switches on fading for path A.

8.4 High Speed Train

The High Speed Train dynamic fading configurations are available with option R&S SMW-K71.

Example: Enabling and configuring a high speed train propagation

The following is an example on how to configure the settings without using a predefined standard.

```
SOURce1:FSIMulator:CONFiguration HSTRain
SOURce1:FSIMulator:HSTRain:PROFile PDOPpler
SOURce1:FSIMulator:HSTRain:SPEed 100kmh
SOURce1:FSIMulator:HSTRain:DISTance:MINimum 20m
SOURce1:FSIMulator:HSTRain:DISTance:STARt 2000m
SOURce1:FSIMulator:HSTRain:PATH:STATe ON
SOURce1:FSIMulator:HSTRain:STATe ON
SOURce1:FSIMulator:HSTRain:FDOPpler?
// 92.657 Hz
```

Example: Configuring a high speed train scenario for BS tests

The following is an example on how to configure fading simulator to generate a HST BS test signal according to 3GPP TS36.104.

For frequency Band 1 tests, the specification defines:

F_{DL} = 2.14 GHz, F_{UL} = 1.95 GHz

and F_D = 1140 Hz

```
SOURce1:FSIMulator:PRESet
SOURce1:FSIMulator:STANdard G3HST1OSDU
SOURce1:FREQuency:CW 1.95E9
SOURce1:FSIMulator:HSTRain:DOWNlink:FREQuency:STATe ON
SOURce1:FSIMulator:HSTRain:DOWNlink:FREQuency 2.14E9
SOURce1:FSIMulator:HSTRain:PATH:STATe ON
SOURce1:FSIMulator:HSTRain:STATe ON
SOURce1:FSIMulator:HSTRain:FDOPpler?
// 1136.89307687654
```

[:SOURce<hw>]:FSIMulator:HSTRain:DISTance:MINimum 154
[:SOURce<hw>]:FSIMulator:HSTRain:DISTance:STARt 154
[:SOURce<hw>]:FSIMulator:HSTRain:SPEed 155
[:SOURce<hw>]:FSIMulator:HSTRain:FDOPpler? 155
[:SOURce<hw>]:FSIMulator:HSTRain:PATH:STATe 155
[:SOURce<hw>]:FSIMulator:HSTRain:PROFile 156
[:SOURce<hw>]:FSIMulator:HSTRain:KFACtor 156
[:SOURce<hw>]:FSIMulator:HSTRain:DOWNlink:FREQuency:STATe 156
[:SOURce<hw>]:FSIMulator:HSTRain:DOWNlink:FREQuency 156
[:SOURce<hw>]:FSIMulator:HSTRain:STATe 157

[:SOURce<hw>]:FSIMulator:HSTRain:DISTance:MINimum <Minimum>

Sets the parameter D_{min}, i.e. the distance between the BS and the railway track.

Parameters:

<Minimum> float

Range: 1 to 100
Increment: 0.1
*RST: 2

Example: see example "Enabling and configuring a high speed train propagation" on page 153

Manual operation: See "D (min)" on page 76

[:SOURce<hw>]:FSIMulator:HSTRain:DISTance:STARt <Start>

Sets the parameter D_S, i.e. the initial distance $D_S/2$ between the train and the BS at the beginning of the simulation.

Parameters:

<Start> integer

Range: 20 to 2000
*RST: 300

Example: see example "Enabling and configuring a high speed train propagation" on page 153

Manual operation: See "D (S)" on page 76

[:SOURce<hw>]:FSIMulator:HSTRain:SPEed <Speed>

Sets the velocity parameter , i.e. the speed of the moving receiver in m/s.

Parameters:

<Speed> float

Range: 0.001 to dynamic
Increment: 0.001
*RST: 83.333

Example: see example "Enabling and configuring a high speed train propagation" on page 153

Manual operation: See "Speed" on page 76

[:SOURce<hw>]:FSIMulator:HSTRain:FDOPpler?

Queries the maximum Doppler Shift for the selected configuration.

Return values:

<FDoppler> float

Range: 0 to 1000
Increment: 0.01
*RST: 0

Example: see example "Configuring a high speed train scenario for BS tests" on page 154

Usage: Query only

Manual operation: See "Profile" on page 76

[:SOURce<hw>]:FSIMulator:HSTRain:PATH:STATe <State>

Activates/deactivates the selected path for the High Speed Train fading configurations.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 1

Example: see example "Enabling and configuring a high speed train propagation" on page 153

Manual operation: See "State Path" on page 44

[:SOURce<hw>]:FSIMulator:HSTRain:PROFile <Profile>

Determines the fading profile for the selected scenario. The fading profile determines which transmission path is simulated.

Parameters:

<Profile> SPATh | PDOPpler | RAYLeigh

*RST: PDOPpler

Example: see example "Enabling and configuring a high speed train propagation" on page 153

Manual operation: See "Profile" on page 76

[:SOURce<hw>]:FSIMulator:HSTRain:KFACtor <KFactor>

Sets the Rician factor K for high speed train scenario 2.

Parameters:

<KFactor> float

Range: -30 to 30
Increment: 0.01
*RST: 10

Example:

```
SOURce1:FSIMulator:PRESet
SOURce1:FSIMulator:STANdard G3HST2TLC
SOURce1:FSIMulator:HSTRain:KFACtor 10
```

Manual operation: See "K (Rician factor)" on page 77

[:SOURce<hw>]:FSIMulator:HSTRain:DOWNlink:FREQuency:STATe <HstDlFreqState>

Enables the definition of virtual downlink frequency.

Parameters:

<HstDlFreqState> 0 | 1 | OFF | ON

*RST: 0

Example: see example "Configuring a high speed train scenario for BS tests" on page 154

Manual operation: See "Consider DL RF" on page 77

[:SOURce<hw>]:FSIMulator:HSTRain:DOWNlink:FREQuency <HstDlFreq>

Sets the virtual downlink frequency, necessary to calculate the UL Doppler shift.

Parameters:

<HstDlFreq> float

Range: 100E3 to 6E9
Increment: 0.01
*RST: 1E9

Example: see example "Configuring a high speed train scenario for BS tests" on page 154

Manual operation: See "Virtual DL RF" on page 77

[:SOURce<hw>]:FSIMulator:HSTRain:STATe <State>

Activates/deactivates simulation of High Speed Train propagation according to the selected scenario 1 or 3.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: see example "Enabling and configuring a high speed train propagation" on page 153

Manual operation: See "Configuration" on page 27
See "State" on page 76

8.5 Moving Propagation

The moving propagation dynamic fading configurations are available with option R&S SMW-K71.

[:SOURce<hw>]:FSIMulator:MDELay:ALL:MOVing:VPERiod 157
[:SOURce<hw>]:FSIMulator:MDELay:ALL:MOVing:DELay:VARiation 158
[:SOURce<hw>]:FSIMulator:MDELay:CHANnel:MODE 158
[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:CPHase 159
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:DELay:MEAN 159
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:DELay:VARiation 160
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:LOSS 160
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:STATe 160
[:SOURce<hw>]:FSIMulator:MDELay:MOVing:VPERiod 160
[:SOURce<hw>]:FSIMulator:MDELay:REFerence:DELay 161
[:SOURce<hw>]:FSIMulator:MDELay:REFerence:LOSS 161
[:SOURce<hw>]:FSIMulator:MDELay:REFerence:STATe 161
[:SOURce<hw>]:FSIMulator:MDELay:STATe 162

[:SOURce<hw>]:FSIMulator:MDELay:ALL:MOVing:VPERiod <VPeriod>

Sets the speed of the delay variation of the moving fading paths for moving propagation with all moving channels. A complete cycle comprises one pass through this "Variation Period".

Parameters:

<VPeriod> float

Range: 5 to 200
Increment: 0.1
*RST: 25

Example: `FSIM:CONF MDEL`
selects a moving propagation configuration.
`FSIM:MDEL:CHAN:MODE ALL`
enables all moving channels.
`FSIM:MDEL:STAT ON`
activates the moving propagation for fader A.
`FSIM:MDEL:ALL:MOV:VPER 50 s`
sets the period for the delay variation to 100 s.

Manual operation: See "Variation Period" on page 65

[:SOURce<hw>]:FSIMulator:MDELay:ALL:MOVing:DELay:VARiation <Variation>

This command enters the range for the delay of the moving fading paths for moving propagation with all moving channels. The delay of the moving path slowly varies sinusoidally within this range.

Parameters:

<Variation> float

Range: 0.3E-6 to 10E-6
Increment: 10E-9
*RST: 5E-6

Example: `FSIM:CONF MDEL`
selects a moving propagation configuration.
`FSIM:MDEL:CHAN:MODE ALL`
enables all moving channels.
`FSIM:MDEL:STAT ON`
activates the moving propagation for fader A.
`FSIM:MDEL:ALL:MOV:DEL:VAR 1E-5`
sets the range 10 us for the delay of the moving fading path.

Manual operation: See "Delay Variation (Peak-Peak)" on page 65

[:SOURce<hw>]:FSIMulator:MDELay:CHANnel:MODE <Mode>

Determines whether only one or several moving channels are simulated.

Parameters:

<Mode> ONE | ALL

*RST: ONE

Example: `FSIM:CONF MDEL`
selects a moving propagation configuration.
`FSIM:MDEL:CHAN:MODE ALL`
enables all moving channels.

Manual operation: See "Moving Channels" on page 29

[:SOURce<hw>]:FSIMulator:MDELay:DEL30:GROup<st>:PATH<ch>:CPHase <CPhase>

These commands determine the phase for constant phase fading for the "Standard Delay", and "Moving Propagation All Moving Channels" fading configurations.

Parameters:

<CPhase> float

Range: 0 to 359.9
Increment: 0.1
*RST: 0

Example: `FSIM:DEL:STAT ON`
activates the `Standard Delay` fading configuration.
`FSIM:DEL:GRO2:PATH:PROF CPH`
selects the `Constant Phase` fading profile for fading path 1 of group 2.
`FSIM:DEL:GRO2:PATH:CPH 5DEG`
sets a phase of 5 DEG for fading path 1 of group 2. The path is multiplied by this phase.

[:SOURce<hw>]:FSIMulator:MDELay:MOVing:DELay:MEAN <Mean>

Sets the mean delay of the moving fading path for moving propagation.

Parameters:

<Mean> float

Range: 0 to 40E-6
Increment: 10E-9
*RST: 3.5E-6

Example: `FSIM:MDEL:STAT ON`
sets moving propagation.
`FSIM:MDEL:MOV:DEL:VAR 1E-5`
sets the range 10 us (+/- 5 us) for the variation of the delay of the moving fading path.
`FSIM:MDEL:MOV:DEL:MEAN 9E-6`
sets the mean delay of the moving path to 9 us.
`FSIM:MDEL:MOV:VPER 105`
sets a period of 105 s for the sinusoidal variation of the delay of the moving path. The delay of the moving path now varies once sinusoidal in 105 s between 4 us and 14 us.

Manual operation: See "Delay" on page 64

[:SOURce<hw>]:FSIMulator:MDELay:MOVing:DELay:VARiation <Variation>

Enters the range for the delay of the moving fading path for moving propagation. The delay of the moving path slowly varies sinusoidal within this range.

Parameters:

<Variation> float

Range: 0.3E-6 to dynamic
Increment: 10E-9
*RST: 5E-6

Example: `FSIM:MDEL:MOV:DEL:VAR 1E-5`
sets the range 10 us for the delay of the moving fading path.

Manual operation: See "Variation (Peak-Peak)" on page 64

[:SOURce<hw>]:FSIMulator:MDELay:MOVing:LOSS <Loss>

Sets the insertion loss of the moving path for moving propagation.

Parameters:

<Loss> float

Range: 0 to 50
Increment: 0.001
*RST: 0

Example: `FSIM:MDEL:MOV:LOSS 12 dB`
sets the loss for the moving fading path.

Manual operation: See "Path Loss" on page 64

[:SOURce<hw>]:FSIMulator:MDELay:MOVing:STATe <State>

This command activates the moving fading path for moving propagation.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 1

Example: `FSIM:MDEL:STAT ON`
sets moving propagation.
`FSIM:MDEL:MOV:STAT ON`
activates the moving path for moving propagation.

Manual operation: See "State" on page 63

[:SOURce<hw>]:FSIMulator:MDELay:MOVing:VPERiod <VPeriod>

This command sets the speed of the delay variation of the moving fading path for moving propagation. A complete cycle comprises one pass through this "Variation Period".

Parameters:

<VPeriod> float

Range: 10 to 500
Increment: 0.1
*RST: 157

Example: `FSIM:MDEL:MOV:VPER 100 s`
sets the period for the delay variation to 100 s.

Manual operation: See "Variation Period" on page 64

[:SOURce<hw>]:FSIMulator:MDELay:REFerence:DELay <Delay>

This command enters the delay of the reference path for moving propagation.

Parameters:

<Delay> float

Range: 0 to 40E-6
Increment: 10E-9
*RST: 0

Example: `FSIM:MDEL:REF:DEL 1E-5`
sets the range to 10 us for the delay of the reference path.

Manual operation: See "Delay" on page 63

[:SOURce<hw>]:FSIMulator:MDELay:REFerence:LOSS <Loss>

Sets the loss of the reference path for moving propagation.

Parameters:

<Loss> float

Range: 0 to 50
Increment: 0.001
*RST: 0

Example: `FSIM:MDEL:REF:LOSS 12 dB`
sets the insertion loss for the reference path.

Manual operation: See "Path Loss" on page 63

[:SOURce<hw>]:FSIMulator:MDELay:REFerence:STATe <State>

This command activates the reference path for moving propagation.

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 1

Example: `FSIM:MDEL:STAT ON`
sets moving propagation.
`FSIM:MDEL:REF:STAT ON`
activates the reference path for moving propagation.

Manual operation: See "State" on page 63

[:SOURce<hw>]:FSIMulator:MDELay:STATe <State>

This command activates the moving propagation fading configuration. The paths and the fading simulator must be switched on separately (`SOURce:FSIMulator:MDELay:MOVing|REFerence:STATe ON` and `SOURce:FSIMulator ON`).

Parameters:
<State> 0 | 1 | OFF | ON
*RST: 0

Example: `FSIM:MDEL:STAT ON`
sets moving propagation for fader A.

Manual operation: See "Configuration" on page 27

8.6 MIMO Settings

The MIMO configurations require additional options:

- for up to 2x2 MIMO configurations, 2x option R&S SMW-B14+R&S SMW-K74 are required
- the MxN MIMO configurations with M>2 or N>2 require 4xR&S SMW-B14+R&S SMW-K74

Placeholder <path>

To simplify the description of the remote control commands, the placeholder `<path>` is introduced. Replace this placeholder `<path>` with `AB`, `AC`, etc.

The description of each command containing this placeholder provides a link to the related commands with their correct syntax.

The replacement of the place holder `<path>` is mandatory, i.e. remote control commands containing this placeholder are not recognized and accepted by the instrument.

[:SOURce<hw>]:FSIMulator:MIMO:CAPability? 163
[:SOURce<hw>]:FSIMulator:MIMO:COPY:NEXT 163
[:SOURce<hw>]:FSIMulator:MIMO:COPY:ALL 163
[:SOURce<hw>]:FSIMulator:MIMO:COPY:PREVious 164
[:SOURce<hw>]:FSIMulator:MIMO:MDLoad 164
[:SOURce<hw>]:FSIMulator:MIMO:MDSTore 164

[:SOURce<hw>]:FSIMulator:MIMO:TAP 164
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:IMAGinary 165
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:IMAGinary 165
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:PHASe 165
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:PHASe 165
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:MAGNitude 165
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:MAGNitude 165
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:REAL 166
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:REAL 166
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ACCept 166
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:CONFlict? 167
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:MODE 167
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ROW<di>:COLumn<st>:PHASe 167
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ROW<di>:COLumn<st>:MAGNitude 168
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:PRESet 168
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:<path>:GAIN 168
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:<path>:PHASe 169

[:SOURce<hw>]:FSIMulator:MIMO:CAPability?

Queries the supported MIMO configurations.

Return values:
<MimoCapability> string

Example:
```
:SOURce1:FSIMulator:MIMO:CAPability?
Response: "M2X2,M2X4,M4X2,M2X3,M3X2,M1X2,..."
```

Usage: Query only

[:SOURce<hw>]:FSIMulator:MIMO:COPY:NEXT

Copies the matrix values of the current tap to the subsequent tap. If the current tap is the last tap, the command is discarded.

See also `[:SOURce<hw>]:FSIMulator:MIMO:COPY:ALL` on page 163.

Usage: Event

Manual operation: See "Copy To Next" on page 92

[:SOURce<hw>]:FSIMulator:MIMO:COPY:ALL

Applies the matrix values of the current tap to all taps.

Usage: Event

Options: R&S SMW-B14/K74

Manual operation: See "Copy To All" on page 92

[:SOURce<hw>]:FSIMulator:MIMO:COPY:PREVious

This command copies the matrix values of the current tap to the next lower tap.

Example: `FSIM:MIMO:COPY:PREV`
copies the settings of the current tap to the next lower tap.

Usage: Event

Manual operation: See "Copy To Prev" on page 92

[:SOURce<hw>]:FSIMulator:MIMO:MDLoad <MDLoad>

This command loads a file with saved MIMO settings.

Setting parameters:
<MDLoad> string

Example: `FSIM:MIMO:MDL 'MIMO_Settings'`
loads the settings file.

Usage: Setting only

[:SOURce<hw>]:FSIMulator:MIMO:MDSTore <MDStore>

This command save the MIMO settings in a file.

Setting parameters:
<MDStore> string

Example: `FSIM:MIMO:MDST 'MIMO_Settings'`
saves the MIMO settings in a file.

Usage: Setting only

[:SOURce<hw>]:FSIMulator:MIMO:TAP <Tap>

Sets the current tap.

Parameters:
<Tap> TAP1 | TAP2 | TAP3 | TAP4 | TAP5 | TAP6 | TAP7 | TAP8 | TAP9 | TAP10 | TAP11 | TAP12 | TAP13 | TAP14 | TAP15 | TAP16 | TAP17 | TAP18 | TAP19 | TAP20

*RST: TAP1

Example: `SORce1:FSIMulator:MIMO:TAP TAP15`

Manual operation: See "Current Path (Tap) #" on page 92

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:IMAGinary <Imaginary>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:IMAGinary <Imaginary>

Sets the value for the imaginary part of the receiver/transmitter correlation.

Note: In case that the values for the real part and the imaginary part are both set to 0, the phase value will also be set to 0 when changing the data format.

Parameters:

<Imaginary> float

Range: -1 to 1
Increment: 0.001
*RST: 0

Example: `SOURce1:FSIMulator:MIMO:TAP2:KRONecker:CORRelation:TX:ROW1:COLumn2:IMAGinary 0.5`
sets the imaginary part of the Tx correlation AB to 0.5.

Options: up to 4xR&S SMW-B14 and R&S SMW-K74

Manual operation: See "Tx Correlation Coefficients, Phase/Imag" on page 95

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:PHASe <Phase>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:PHASe <Phase>

Sets the value for the phase of the receiver/transmitter correlation.

Note: In case that the values for the real part and the imaginary part are both set to 0, the phase value will also be set to 0 when changing the data format.

Parameters:

<Phase> float

Range: 0 to 360
Increment: 0.02
*RST: 0

Example: `SOURce1:FSIMulator:MIMO:TAP2:KRONecker:CORRelation:TX:ROW1:COLumn2:PHASe 30`
sets the phase of the Tx correlation AB to 30 degrees.

Options: up to 4xR&S SMW-B14 and R&S SMW-K74

Manual operation: See "Tx Correlation Coefficients, Phase/Imag" on page 95

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:MAGNitude <Magnitude>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:MAGNitude <Magnitude>

Sets the ratio of the receiver/transmitter correlation.

Note: In case that the values for the real part and the imaginary part are both set to 0, the phase value will also be set to 0 when changing the data format.

Parameters:

<Magnitude> float

Range: 0 to 1
Increment: 0.001
*RST: 0

Example: `SOURce1:FSIMulator:MIMO:TAP2:KRONecker:CORRelation:TX:ROW1:COLumn2:MAGNitude 0.5`
sets the ratio of the Tx correlation AB to 0.5.

Options: up to 4xR&S SMW-B14 and R&S SMW-K74

Manual operation: See "Tx Correlation Coefficients, Magnitude/Real" on page 94

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:RX:ROW<di>:COLumn<st>:REAL <Real>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:KRONecker:CORRelation:TX:ROW<di>:COLumn<st>:REAL <Real>

Sets the value for the real part of the receiver/transmitter correlation.

Note: In case that the values for the real part and the imaginary part are both set to 0, the phase value will also be set to 0 when changing the data format.

Parameters:

<Real> float

Range: -1 to 1
Increment: 0.001
*RST: 0

Example: `SOURce1:FSIMulator:MIMO:TAP2:KRONecker:CORRelation:TX:ROW1:COLumn2:REAL 0.5`
sets the value for the real part of the Tx correlation AB to 0.5.

Options: up to 4xR&S SMW-B14 and R&S SMW-K74

Manual operation: See "Tx Correlation Coefficients, Magnitude/Real" on page 94

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ACCept

Accepts the values for the phase/imaginary and the real/ration part of the correlation.

Example: `FSIM:MIMO:TAP2:MATR:ACC`
accepts the values for the phase/imaginary and the real/ration part of the correlation

Usage: Event

Options: R&S SMW-B14/-K71/-K74

Manual operation: See "Accept" on page 111

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:CONFlict?

Queries whether there is a matrix conflict or not.

Return values:
<Conflict> 0 | 1 | OFF | ON

Example: `FSIM:MIMO:TAP2:MATR:CONF?`
queries whether there is a matrix conflict or not

Usage: Query only

Options: R&S SMW-B14/-K71/-K74

Manual operation: See "Conflict" on page 111

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:MODE <Mode>

Sets the input mode for the Rx and Tx correlation values (matrix mode).

Parameters:
<Mode> INDividual | KRONecker | AOAaod | SCWI
*RST: INDividual

Example: `FSIM:MIMO:TAP2:MATR:MODE IND`
selects the matrix mode individual.

Options: R&S SMW-B14/-K71/-K74

Manual operation: See "Matrix Mode" on page 92

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ROW<di>:COLumn<st>:
PHASe <Phase>

This command enters the value for the phase/imaginary part of the correlation.

Suffix:
<di> 1..4

<st> 1..4

Parameters:
<Phase> float
Range: 0 to 360
Increment: 0.02
*RST: 0

Example: `FSIM:MIMO:TAP2:MATR:ROW1:COL1:PHAS 90`
sets the correlation value to the specified value.

Options: R&S SMW-B14/-K71/-K74

Manual operation: See "Phase/Imag" on page 111

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:MATRix:ROW<di>:COLumn<st>:MAGNitude <Magnitude>

Determines the value for the real/magnitude part of the correlation.

Suffix:
<di> 1..4

<st> 1..4

Parameters:
<Magnitude> float

Range: 0 to 1
Increment: 0.0001
*RST: 1

Example: `FSIM:MIMO:TAP2:MATR:ROW1:COL1:MAGN 0.5`
sets the correlation value to the specified value.

Options: R&S SMW-B14/-K71/-K74

Manual operation: See "Real/Magnitude" on page 111

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:PRESet

The command presets the vector matrix to an unitary matrix.

Example: `FSIM:MIMO:TAP2:GVEC:PRES`
resets the gain vector matrix.

Usage: Event

Manual operation: See "Set to Unity" on page 112

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:<path>:GAIN

Sets the relative gain in the selected path.

For the correct syntax of the other available commands, see chapter 8.7.1, "Relative Gain", on page 169.

Parameters:
<Gain> float

Range: -50 to 0
Increment: 0.01
*RST: 0

Example: `SOURce1:FSIMulator:MIMO:TAP2:GVECtor:AA:GAIN -3`
decreases the level in path AA by 3 dB.

Options: up to 4xR&S SMW-B14 and R&S SMW-K74

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:<path>:PHASe

Sets the phase shift of the selected path.

For the correct syntax of the other available commands, see chapter 8.7.2, "Phase Shift", on page 170.

Parameters:

<Phase> float

Range: 0 to 360
Increment: 0.02
*RST: 0

Example: `SOURce1:FSIMulator:MIMO:TAP2:GVECtor:AA:PHASe 45`
shifts the phase in path AA by 45 degree.

Options: up to 4xR&S SMW-B14 and R&S SMW-K74

8.7 MIMO Vector Settings

8.7.1 Relative Gain

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AA:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AB:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AC:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AD:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AE:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AF:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AG:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AH:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BA:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BB:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BC:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BD:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BE:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BF:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BG:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BH:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CA:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CB:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CC:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CD:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CE:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CF:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CG:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CH:GAIN <Gain>

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DA:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DB:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DC:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DD:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DE:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DF:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DG:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DH:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EA:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EB:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EC:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:ED:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EE:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EF:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EG:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EH:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FA:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FB:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FC:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FD:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FE:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FF:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FG:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FH:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GA:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GB:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GC:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GD:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GE:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GF:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GG:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GH:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HA:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HB:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HC:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HD:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HE:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HF:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HG:GAIN <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HH:GAIN <Gain>

For description, refer to [:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:<path>:GAIN on page 168.

8.7.2 Phase Shift

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AA:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AB:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AC:PHASe <Gain>

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AD:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AE:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AF:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AG:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:AH:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BA:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BB:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BC:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BD:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BE:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BF:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BG:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:BH:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CA:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CB:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CC:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CD:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CE:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CF:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CG:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:CH:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DA:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DB:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DC:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DD:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DE:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DF:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DG:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:DH:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EA:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EB:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EC:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:ED:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EE:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EF:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EG:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:EH:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FA:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FB:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FC:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FD:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FE:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FF:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FG:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:FH:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GA:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GB:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GC:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GD:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GE:PHASe <Gain>

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GF:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GG:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:GH:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HA:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HB:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HC:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HD:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HE:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HF:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HG:PHASe <Gain>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:HH:PHASe <Gain>

For description, refer to `[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:GVECtor:<path>:PHASe` on page 169.

8.8 TGn Settings

The MIMO configurations are available with option R&S SMW-K74.

Example: Simulating one path TGn fading with two rays with different distributions

In the following example we assume that a MIMO fading configuration is enabled, e.g 2x2 MIMO. One MIMO path is activated, the default path settings are used.

```
// ********************************************************************
// Enable the corresponding matrix mode and set the relevant SCM settings
// ********************************************************************

SOURce:FSIMulator:MIMO:TAP:MATRix:MODE AOAaod
SOURce:FSIMulator:MIMO:TGN:ANTenna:DISTance:RX 0.5
SOURce:FSIMulator:MIMO:TGN:ANTenna:DISTance:TX 0.5

// ********************************************************************
// Set ray#1 to simulate signal scattered by
// obstacles causing static fading distribution, e.g. a building
// ********************************************************************
SOURce:FSIMulator:MIMO:TAP:TGN:RAY1:GAIN 0
SOURce:FSIMulator:MIMO:TAP:TGN:RAY1:ARRival:ANGLe 72
SOURce:FSIMulator:MIMO:TAP:TGN:RAY1:ARRival:SPRead 5
SOURce:FSIMulator:MIMO:TAP:TGN:RAY1:DEParture:ANGLe 15
SOURce:FSIMulator:MIMO:TAP:TGN:RAY1:DEParture:SPRead 3
SOURce:FSIMulator:MIMO:TAP:TGN:DISTribution EQUal
SOURce:FSIMulator:MIMO:TAP:TGN:RAY1:STATe ON

// ********************************************************************
// Set ray#2 to simulate signal scattered by
// obstacles causing Gaussian fading distribution, e.g. a tree
// ********************************************************************
```

```
SOURce:FSIMulator:MIMO:TAP:TGN:RAY2:GAIN -10
SOURce:FSIMulator:MIMO:TAP:TGN:RAY2:ARRival:ANGLe 23
SOURce:FSIMulator:MIMO:TAP:TGN:RAY2:ARRival:SPRead 7
SOURce:FSIMulator:MIMO:TAP:TGN:RAY2:DEParture:ANGLe 25
SOURce:FSIMulator:MIMO:TAP:TGN:RAY2:DEParture:SPRead 5
SOURce:FSIMulator:MIMO:TAP:TGN:DISTribution GAUSs
SOURce:FSIMulator:MIMO:TAP:TGN:RAY2:STATe ON

// ****************************************************************
// Query the resulting matrix correlation coefficients with the
// SOURce:FSIMulator:MIMO:TAP:MATRix:... commands
// ****************************************************************
```

[:SOURce<hw>]:FSIMulator:MIMO:TGN:ANTenna:DISTance:RX 173
[:SOURce<hw>]:FSIMulator:MIMO:TGN:ANTenna:DISTance:TX 173
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:DISTribution 173
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:ARRival:ANGLe 174
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:DEParture:ANGLe 174
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:ARRival:SPRead 174
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:DEParture:SPRead 174
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:GAIN 174
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:STATe 175

[:SOURce<hw>]:FSIMulator:MIMO:TGN:ANTenna:DISTance:RX <RxAntDist>
[:SOURce<hw>]:FSIMulator:MIMO:TGN:ANTenna:DISTance:TX <TxAntDist>

Sets the RX/TX antenna distance in the SCM fading model.

Parameters:

<TxAntDist> float

Range: 0.1 to 2
Increment: 0.1
*RST: 0.5

Example: see example "Simulating one path TGn fading with two rays with different distributions" on page 172.

Manual operation: See "RX/TX Antenna Distance" on page 96

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:DISTribution <Distribution>

Selects one of the proposed statistical functions to determine the distribution of the selected cluster.

Parameters:

<Distribution> LAPLace | EQUal | GAUSs

*RST: EQUal

Example: see example "Simulating one path TGn fading with two rays with different distributions" on page 172.

Manual operation: See "Distribution" on page 97

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:ARRival:ANGLe <ArrAngle>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:DEParture:ANGLe <DepAngle>

Sets the AoA (Angle of Arrival) / AoD (Angle of Departure) of the selected ray.

Parameters:

<DepAngle> float

Range: 0 to 359.9
Increment: 0.001
*RST: 0

<ArrAngle> float

Range: 0 to 359.9
Increment: 0.001
*RST: 0

Example: see example "Simulating one path TGn fading with two rays with different distributions" on page 172.

Manual operation: See "Angle of Departure (AoD)" on page 97

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:ARRival:SPRead <ArrSpread>
[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:DEParture:SPRead <DepSpread>

Sets the AoD (Angle of Departure) / AoA (Angle of Arrival) spread (AS) of the selected ray.

Parameters:

<DepSpread> float

Range: 0.1 to 75
Increment: 0.001
*RST: 0.1

<ArrSpread> float

Range: 0.1 to 75
Increment: 0.001
*RST: 0.1

Example: see example "Simulating one path TGn fading with two rays with different distributions" on page 172.

Manual operation: See "AoD Spread" on page 97

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:GAIN <Gain>

Sets the relative gain (in dB) of the selected ray.

Parameters:

<Gain> float

Range: -50 to 0
Increment: 0.001
*RST: 0

Example: see example "Simulating one path TGn fading with two rays with different distributions" on page 172.

Manual operation: See "Relative Gain /dB" on page 97

[:SOURce<hw>]:FSIMulator:MIMO:TAP<ch>:TGN:RAY<st>:STATe <RayState>

Enables/disables the selected ray.

Parameters:

<RayState> 0 | 1 | OFF | ON

*RST: 0

Example: see example "Simulating one path TGn fading with two rays with different distributions" on page 172.

Manual operation: See "Ray State" on page 97

8.9 SCME, WINNER I, WINNER II and Antenna Model Settings

The SCME, WINNER I and II, and the antenna model settings are available with option R&S SMW-K72.

Example: Defining an antenna model

The following is a simple example on how to configure and enable an antenna model.

```
// Enable 2x2 MIMO configuration
SCONfiguration:MODE ADVanced
SCONfiguration:FADing MIMO2X2
SCONfiguration:APPLy

// select SCME/WINNER matrix mode
// configure the spacial channel model
SOURce1:FSIMulator:MIMO:TAP TAP1
SOURce1:FSIMulator:MIMO:TAP1:MATRix:MODE SCWI
SOURce1:FSIMulator:MIMO:SCWI:TAP1:SPEed 30kmh
SOURce1:FSIMulator:DEL:GROup1:PATH1:SPEed?
// Response:  8.333
SOURce1:FSIMulator:MIMO:SCWI:TAP1:DOT 120
SOURce1:FSIMulator:DEL:GROup1:PATH1:FRATio?
// Response: -0.5
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:TAP1:STATe 1
```

```
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:TAP1:SUBCluster1:STATe 1
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:GAIN 0
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:TAP1:SUBCluster1:GAIN?
// Response: -3.01029995663981
SOURce1:FSIMulator:DEL:GROup1:PATH1:LOSS?
// Response: 3.01
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:ARRival:ANGLe 0.7
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:DEParture:ANGLe 6.6
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:DEParture:SPRead 5
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:ARRival:SPRead 35
SOURce1:FSIMulator:MIMO:SCWI:CLUSter1:DISTribution LAPL

// enable channel polarization
SOURce1:FSIMulator:MIMO:ANTenna:MODeling:STATe 1
SOURce:FSIMulator:MIMO:ANTenna:POLarization:PRATio:VERTical 9
SOURce:FSIMulator:MIMO:ANTenna:POLarization:PRATio:HORizontal 9

// configure the Tx antenna array (BS)
SOURce1:FSIMulator:MIMO:ANTenna:TX:PATTern DIPole
SOURce1:FSIMulator:MIMO:ANTenna:TX:POLarization:ANGLe POLCROSS45
SOURce1:FSIMulator:MIMO:ANTenna:TX:COLumn:SIZE ANT01
SOURce1:FSIMulator:MIMO:ANTenna:TX:ROWS:SIZE ANT01
SOURce1:FSIMulator:MIMO:ANTenna:TX:ESPacing:CROSS 4

// configure the Rx antenna array (MS)
SOURce:FSIMulator:MIMO:ANTenna:RX:PATTern ISO
SOURce:FSIMulator:MIMO:ANTenna:RX:POLarization:ANGLe POLCROSS90
SOURce:FSIMulator:MIMO:ANTenna:RX:COLumn:SIZE ANT01
SOURce:FSIMulator:MIMO:ANTenna:RX:ROWS:SIZE ANT01
SOURce:FSIMulator:MIMO:ANTenna:RX:ESPacing:CROSS?
// 0.5

SOURce1:FSIMulator:STATe 1

// loading and using an user defined antenna pattern
// query predefined antenna pattern files (*.ant_pat)
SOURce:FSIMulator:MIMO:ANTenna:PATTern:CATalog?
// Response: 3Sector,6Sector,Dipole,Isotropic
query existing user defined antenna pattern files (*.ant_pat)
MMEMory:CDIRectory "/var/user"
SOURce:FSIMulator:MIMO:ANTenna:PATTern:CATalog?
// Response: ant.ant_pat
SOURce1:FSIMulator:MIMO:ANTenna:TX:PATTern USER
SOURce1:FSIMulator:MIMO:ANTenna1:TX:PFILe "/var/user/ant"
```

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:TAP<st>:SPEed <Speed>

Sets the speed of the mobile station.

Parameters:

<Speed> float

Range: 0 to 27778
Increment: 0.001
*RST: 0.83333

Example: see example "Defining an antenna model" on page 175

Manual operation: See "MS Speed" on page 101

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:TAP<st>:DOT <DotAngle>

Sets the direction of travel of the mobile station.

Parameters:

<DotAngle> float

Range: 0 to 359.9
Increment: 0.1
*RST: 0

Example: see example "Defining an antenna model" on page 175

Manual operation: See "MS DoT (Direction of Travel)" on page 102

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:STATe <SCWIClustState>

Enables/disables the selected cluster.

Parameters:

<SCWIClustState> 0 | 1 | OFF | ON

*RST: 0

Example: see example "Defining an antenna model" on page 175

Manual operation: See "Cluster State" on page 102

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:GAIN <SCWIGain>

Sets the relative gain (in dB) of the selected cluster.

Parameters:

<SCWIGain> float

Range: -50 to 0
Increment: 0.001
*RST: 0

Example: see example "Defining an antenna model" on page 175

Manual operation: See "Relative Gain /dB" on page 102

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:ARRival:ANGLe
<SCWIArrAngle>
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DEParture:ANGLe
<SCWIDepAngle>

Sets the AoA (Angle of Arrival) / AoD (Angle of Departure) of the selected cluster.

Parameters:

<SCWIDepAngle> float

Range: 0 to 359.9
Increment: 0.001
*RST: 0

<SCWIArrAngle> float

Range: 0 to 360
Increment: 0.1
*RST: 0

Example: see example "Defining an antenna model" on page 175

Manual operation: See "Angle of Departure (AoD)" on page 103

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:ARRival:SPRead
<SCWIArrSpread>
[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DEParture:SPRead
<SCWIDepSpread>

Sets the AoD (Angle of Departure) / AoA (Angle of Arrival) spread (AS) of the selected cluster.

Parameters:

<SCWIDepSpread> float

Range: 1 to 75
Increment: 0.001
*RST: 1

Example: see example "Defining an antenna model" on page 175

Manual operation: See "AoD Spread" on page 103

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:DISTribution
<SCWIDistrib>

Sets one of the Power Azimuth Spectrum (PAS) distributions.

Parameters:

<SCWIDistrib> LAPLace | EQUal | GAUSs

*RST: EQUal

Example: see example "Defining an antenna model" on page 175

Manual operation: See "Distribution" on page 103

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:SUBCluster<di>:STATe <SCWISubClustSta>

If the corresponding cluster is enabled, enables the sub-clusters.

Suffix:
<di> 1 .. 3
sub-cluster number

Parameters:
<SCWISubClustSta> 0 | 1 | OFF | ON
*RST: 0

Example:
```
SOURce1:FSIMulator:MIMO:SCWI:CLUSter2:TAP1:STATe 1
SOURce1:FSIMulator:MIMO:SCWI:CLUSter2:TAP1:SUBCluster2:STATe 1
```

Manual operation: See "State < Sub-Cluster" on page 102

[:SOURce<hw>]:FSIMulator:MIMO:SCWI:CLUSter<ch>:TAP<st>:SUBCluster<di>:GAIN?

Queries the resulting relative gain of an enabled sub-cluster.

Return values:
<SCWISubClusGain> float
Range: -50 to 0
Increment: 0.001
*RST: 0

Example:
```
SOURce1:FSIMulator:MIMO:SCWI:CLUSter2:TAP1:STATe 1
SOURce1:FSIMulator:MIMO:SCWI:CLUSter2:TAP1:SUBCluster2:STATe 1
SOURce1:FSIMulator:MIMO:SCWI:CLUSter2:GAIN 0
SOURce1:FSIMulator:MIMO:SCWI:CLUSter2:TAP1:SUBCluster2:GAIN?
// Response: -5.299
```

Usage: Query only

Manual operation: See "Relative Gain /dB < Sub-Cluster" on page 102

[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:MODeling[:STATe] <AntennaState>

Enables/disables simulation of channel polarization.

Parameters:
<AntennaState> 0 | 1 | OFF | ON
*RST: 0

Example: see example "Defining an antenna model" on page 175

Manual operation: See "Channel Polarization State" on page 106

[:SOURce]:FSIMulator:MIMO:ANTenna:PATTern:CATalog?

Queries the available predefined antenna pattern files (`*.ant_patt`).

Return values:
<Catalog> string

Example: see example "Defining an antenna model" on page 175

Usage: Query only

Manual operation: See "User Defined Antenna Patterns per Row, Column" on page 109

[:SOURce]:FSIMulator:MIMO:ANTenna:POLarization:PRATio:HORizontal <AntPolPowRatHor>
[:SOURce]:FSIMulator:MIMO:ANTenna:POLarization:PRATio:VERTical <AntPolPowRatVer>

Sets the cross polarization power ratio (XPR) in dB.

Parameters:
<AntPolPowRatVer> float

Range: 0 to 20
Increment: 0.001
*RST: 9

Example: see example "Defining an antenna model" on page 175

Manual operation: See "Vertical/Horizontal Cross Polarization Power Ratio" on page 106

[:SOURce]:FSIMulator:MIMO:ANTenna:RX:COLumn:SIZE <AntModRxColSize>
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ROWS:SIZE <AntModRxRowSize>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:COLumn:SIZE <AntModTxColSize>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ROWS:SIZE <AntModTxRowSize>

Sets the number of rows and the number of columns in the antenna array.

Parameters:
<AntModTxRowSize> ANT01 | ANT02 | ANT03 | ANT04 | ANT08

*RST: ANT01

Example: see example "Defining an antenna model" on page 175

Manual operation: See "Number of Rows (M)/Columns (N)" on page 107

[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ESPacing:CROSs <Cross>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ESPacing:CROSs <Cross>
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ESPacing:HORizontal <AntRxEspacHori>
[:SOURce]:FSIMulator:MIMO:ANTenna:RX:ESPacing:VERTical <AntRxEspacVert>

[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ESPacing:HORizontal <AntTxEspacHori>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:ESPacing:VERTical <AntTxEspacVert>

Sets the vertical, horizontal or cross polarized distance between the antennas in the antenna array.

Parameters:

<AntTxEspacVert> float
Range: 0 to 10
Increment: 0.01
*RST: 0.5

<Cross> float
Range: 0 to 10
Increment: 0.01
*RST: 0

Example: see example "Defining an antenna model" on page 175

[:SOURce]:FSIMulator:MIMO:ANTenna:RX:PATTern <AntRxPattDesc>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:PATTern <AntTxPattDesc>

Sets the antenna pattern mode.

Parameters:

<AntTxPattDesc> ISOtropic | USER | SEC3 | SEC6 | DIPole
*RST: ISOtropic

Example: see example "Defining an antenna model" on page 175

Manual operation: See "Antenna Pattern" on page 109

[:SOURce]:FSIMulator:MIMO:ANTenna:RX:POLarization:ANGLe <AntRxPolAngle>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna:TX:POLarization:ANGLe <AntTxPolAngle>

Set the antenna element polarization slant angle.

Parameters:

<AntTxPolAngle> POLCROSS45 | POLCROSS90 | POLCO0 | POLCO90
POLCROSS45 | POLCROSS90
cross-poliarization 45°/90°
POLCO0 | POLCO90
co-poliarization 0°/90° (vertical/horizontal poliarization)
*RST: POLCO0

Example: see example "Defining an antenna model" on page 175

Manual operation: See "Antenna Polarization Slant Angle" on page 107

[:SOURce]:FSIMulator:MIMO:ANTenna<di>:RX:PFILe <RxPattern>
[:SOURce<hw>]:FSIMulator:MIMO:ANTenna<di>:TX:PFILe <TxPattern>

Selects the antenna pattern file (`*.ant_pat`) per antenna.

Suffix:
<di> 1 .. 8
value range depends on the selected system configuration, i.e. the number of Tx and Rx antennas and the antenna array, i.e. number of columns and rows

Parameters:
<TxPattern> string

Example: see example "Defining an antenna model" on page 175

Manual operation: See "User Defined Antenna Patterns per Row, Column" on page 109

8.10 2 Channel Interferer

The 2 channel interferer fading configurations are available with option R&S SMW-K71.

Example: Enabling a two channel interferer fading configuration

The following is a simple example on how to configure and enable a two channel interferer fading configuration.

```
SOURce1:FSIMulator:CONFiguration TCI

SOURce1:FSIMulator:TCInterferer:REFerence:PROFile PDOP
SOURce1:FSIMulator:TCInterferer:REFerence:LOSS 1
SOURce1:FSIMulator:TCInterferer:REFerence:SPEed 2
SOURce1:FSIMulator:TCInterferer:REFerence:FRATio 0.5
SOURce1:FSIMulator:TCInterferer:REFerence:DELay:MINimum 0.00003
SOURce1:FSIMulator:TCInterferer:PERiod 160

SOURce1:FSIMulator:TCInterferer:MOVing:PROFile SPAT
SOURce1:FSIMulator:TCInterferer:REFerence:LOSS 0
SOURce1:FSIMulator:TCInterferer:MOVing:DELay:MINimum 0.00003
SOURce1:FSIMulator:TCInterferer:MOVing:DELay:MAXimum 0.00011
SOURce1:FSIMulator:TCInterferer:MOVing:MMODe SLID

SOURce1:FSIMulator:TCInterferer:REFerence:STATe 1
SOURce1:FSIMulator:TCInterferer:MOVing:STATe 1
SOURce1:FSIMulator:TCINterferer:STATe 0
SOURce1:FSIMulator:STATE 1
```

```
SOURce1:FSIMulator:TCINterferer:REFerence:FDOPpler?
// Response: 3.33564095198152
```

[:SOURce<hw>]:FSIMulator:TCINterferer[:STATe] 183
[:SOURce<hw>]:FSIMulator:TCINterferer:MOVing:DELay:MAXimum 183
[:SOURce<hw>]:FSIMulator:TCINterferer:MOVing:MMODe 183
[:SOURce<hw>]:FSIMulator:TCINterferer:PERiod 184
[:SOURce<hw>]:FSIMulator:TCINterferer:SPEed 184
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:DELay:MINimum 184
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FDOPpler? 185
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FRATio 185
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:LOSS 185
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:PROFile 186
[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:STATe 186

[:SOURce<hw>]:FSIMulator:TCINterferer[:STATe] <State>

Activates the 2 channel interferer fading configuration.

The paths and the fading simulator must be switched on separately, see `[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:STATe` and `[:SOURce<hw>]:FSIMulator[:STATe]`.

Parameters:

<State> 0 | 1 | OFF | ON
*RST: 0

Example: see example "Enabling a two channel interferer fading configuration" on page 182

Manual operation: See "Configuration" on page 27
See "State" on page 69

[:SOURce<hw>]:FSIMulator:TCINterferer:MOVing:DELay:MAXimum <Maximum>

Sets the maximum delay for the moving path.

Parameters:

<Maximum> float
Range: dynamic to 0.001
Increment: 20E-9
*RST: 110E-6

Example: see example "Enabling a two channel interferer fading configuration" on page 182

Manual operation: See "Delay Max (Moving Path)" on page 70

[:SOURce<hw>]:FSIMulator:TCINterferer:MOVing:MMODe <MMode>

Selects the type of moving applied to the moving path.

Parameters:

<MMode> SLIDing | HOPPing

*RST: HOPPing

Example: see example "Enabling a two channel interferer fading configuration" on page 182

Manual operation: See "Moving Mode (Moving Path)" on page 71

[:SOURce<hw>]:FSIMulator:TCINterferer:PERiod <Period>

Sets either the dwell time or the period for a complete cycle of the moving path.

Parameters:

<Period> float

Range: 0.1 to 10
Increment: 0.01
*RST: 2.9 s (for hopping mode) / 160 s (for sliding mode)

Example: see example "Enabling a two channel interferer fading configuration" on page 182

Manual operation: See "Period/Dwell" on page 71

[:SOURce<hw>]:FSIMulator:TCINterferer:SPEed <Speed>

Sets the speed *v* of the moving receiver for 2 channel interferer fading.

Parameters:

<Speed> float

Range: 0 to 27778 (dynamic)
Increment: 0.001
*RST: 0.83333

Example: see example "Enabling a two channel interferer fading configuration" on page 182

Manual operation: See "Speed" on page 70

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:DELay:MINimum <Minimum>

Sets the minimum delay for the reference path and the moving path.

Parameters:

<Minimum> float

Range: 0 to dynamic
Increment: 20E-9
*RST: 0

Example: see example "Enabling a two channel interferer fading configuration" on page 182

Manual operation: See "Delay Min" on page 70

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FDOPpler?

Queries the Doppler frequency of the reference and moving path with 2 channel interferer fading.

Return values:

<FDoppler> float

Range: 0 to 1000
Increment: 0.01
*RST: 0

Example: see example "Enabling a two channel interferer fading configuration" on page 182

Usage: Query only

Manual operation: See "Profile" on page 69
See "Res. Doppler Shift" on page 70

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:FRATio <FRatio>

Sets the ratio of the actual Doppler frequency to the set Doppler frequency for the reference and moving path with 2 channel interferer fading.

Parameters:

<FRatio> float

Range: -1 to 1
Increment: 0.0001
*RST: 0

Example: see example "Enabling a two channel interferer fading configuration" on page 182

Manual operation: See "Freq. Ratio" on page 70

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:LOSS <Loss>

Seta the loss of the reference and moving path with 2 channel interferer fading.

Parameters:

<Loss> float

Range: 0 to 50
Increment: 0.1
*RST: 0

Example: see example "Enabling a two channel interferer fading configuration" on page 182

Manual operation: See "Path Loss" on page 69

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:PROFile <Profile>

Sets the fading profile to be used for the reference and moving path with 2 channel interferer fading.

Parameters:

<Profile> SPATh | PDOPpler | RAYLeigh

*RST: SPATh

Example: see example "Enabling a two channel interferer fading configuration" on page 182

[:SOURce<hw>]:FSIMulator:TCINterferer:REFerence|MOVing:STATe <State>

Activate the reference and moving path of the 2 channel interferer fading configuration.

The 2 channel interferer fading configuration and the fading simulator must be switched on separately, see `[:SOURce<hw>]:FSIMulator:TCINterferer[:STATe]` on page 183 and .`[:SOURce<hw>]:FSIMulator[:STATe]`

Parameters:

<State> 0 | 1 | OFF | ON

*RST: 0

Example: see example "Enabling a two channel interferer fading configuration" on page 182

Manual operation: See "State" on page 69

8.11 Custom Fading Profile

The custom fading profile requires R&S SMW-K72.

Example: Enabling, configuring and disabling a custom fading profile

The following is a simple example on how to configure, enable and disable a custom profile.

```
SOURce1:FSIMulator:DELay:GROup1:PATH2:PROFile CUSTom
SOURce1:FSIMulator:DEL:GROup1:PATH2:CUSTom:DATA 200,100,100,200

SOURce1:FSIMulator:DEL:GROup1:PATH2:CUSTom:DSHape FLAT

SOURce1:FSIMulator:DEL:GROup1:PATH2:PROFile RAYL
```

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DSHape..... 186
[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DATA.....187

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DSHape <DopplerShape>

Sets the doppler shape of the virtual profile.

Parameters:

<DopplerShape> FLAT | RAYLeigh

*RST: RAYLeigh

Example: see example "Enabling, configuring and disabling a custom fading profile" on page 186

Manual operation: See "Doppler Shape" on page 79

[:SOURce<hw>]:FSIMulator:DELay|DEL:GROup<st>:PATH<ch>:CUSTom:DATA <Bandwidth>, <OffsetFreq>, <LowerCutFreq>, <UpperCutFreq>

Sets the paramters of the custom fading profile.

Parameters:

<Bandwidth> float

Range: 50 to 40000
Increment: 1
*RST: 200
Default unit: Hz

<OffsetFreq> float

Range: -23950 to 23950
Increment: 1
*RST: 0
Default unit: Hz

<LowerCutFreq> float

Range: -4000 to 3950
Increment: 1
*RST: 0
Default unit: Hz

<UpperCutFreq> float

Range: -3950 to 4000
Increment: 1
*RST: 100
Default unit: Hz

Example: see example "Enabling, configuring and disabling a custom fading profile" on page 186

Manual operation: See "Bandwidth" on page 79
See "Frequency Offset" on page 79
See "Lower/Upper Cutoff Frequency" on page 79

A Predefined Fading Settings

The predefined fading settings correspond to the test scenarios stipulated in the common mobile radio standards. The following tables provide a listing of the predefined standards along with the underlying test scenarios and the enabled settings.

- CDMA Standards 188
- GSM Standards 191
- NADC Standards 196
- PCN Standards 197
- TETRA Standards 202
- 3GPP Standards 206
- WLAN Standards 217
- DAB Standards 222
- WIMAX Standards 224
- LTE Standards 237
- LTE-MIMO Standards 240
- WIMAX-MIMO Standards 242
- 1xEVDO Standards 246
- 3GPP/LTE High Speed Train 250
- 3GPP/LTE Moving Propagation 252
- SCME Channel Models for MIMO OTA 254
- Watterson Standards 256
- 802.11n-SISO Standards 258
- 802.11n-MIMO Standards 258
- 802.11ac-MIMO Standards 269
- 802.11ac-SISO Standards 279
- 802.11p Channel Models 280

A.1 CDMA Standards

A.1.1 CDMA 1 (8km/h - 2 Path)

Table 1-1: C.S0011-A_MS_Minimum_Performance_Spec.pdf

	Path 1	**Path 2**
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Correlated with:	off	off
Power Ratio [dB]:	0	0

	Path 1	Path 2
Freq Ratio:	0	0
Speed [km/h]:	8	8

also with 15km/h in band class 5

A.1.2 CDMA 2 (30km/h - 2 Path)

Table 1-2: C.S0011-A_MS_Minimum_Performance_Spec.pdf

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Correlated with:	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	30	30

also with 14km/h in band classes 1,4,6,8

also with 58km/h in band class 5

A.1.3 CDMA 3 (30km/h - 1 Path)

Table 1-3: C.S0011-A_MS_Minimum_Performance_Spec.pdf

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Correlated with:	off
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	30

also with 58km/h in band class 5

A.1.4 CDMA 4 (100km/h - 3 Path)

Table 1-4: C.S0011-A_MS_Minimum_Performance_Spec.pdf

	Path 1	Path 2	Path 3
Profile [Type]	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	3
Delay [ns]:	0	2000	14500
LogNormal	off	off	off
Correlated with:	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0	0	0
Speed [km/h]:	100	100	100

also with 192km/h in band class 5

A.1.5 CDMA 5 (0km/h - 2 Path)

Table 1-5: C.S0011-A_MS_Minimum_Performance_Spec.pdf

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Correlated with:	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	0	0

A.1.6 CDMA 6 (3km/h - 1 Path)

Table 1-6: C.S0011-A_MS_Minimum_Performance_Spec.pdf

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Correlated with:	off

	Path 1
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	3

A.2 GSM Standards

A.2.1 GSM TU3 (6 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	0	2	6	8	10
Delay [ns]:	0	200	500	1600	2300	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3	3

A.2.2 GSM TU50 (6 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	0	2	6	8	10
Delay [ns]:	0	200	500	1600	2300	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.2.3 GSM HT100 (6 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1,5	4,5	7,5	8	17,7
Delay [ns]:	0	100	300	500	15000	17200
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100

A.2.4 GSM RA250 (6 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rice	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	4	8	12	16	20
Delay [ns]:	0	100	200	300	400	500
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	6,88	0	0	0	0	0
Freq Ratio:	0,7	0	0	0	0	0
Speed [km/h]:	250	250	250	250	250	250

There has been a change in the specifications TS8916B, Baseline Change from 5.1.0 to 5.2.0. The power ratio for path 1 with Rice fading is now no longer referred only to Rayleigh of path 1. Instead, it is referred to the total power of all of the paths.

The preset value used in the instrument of 6.88 fulfills this requirement. It does not conform to the value given in the specification since the instrument always determines the power ratio for one path. By taking into account the power of the other paths in calculating this value, however, the required power ratio for all six paths is achieved.

A.2.5 GSM ET50 (EQ50) (6 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0	0	0	0

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Delay [ns]:	0	3200	6400	9600	12800	16000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.2.6 GSM ET60 (EQ60) (6 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0	0	0	0
Delay [ns]:	0	3200	6400	9600	12800	16000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	60	60	60	60	60	60

A.2.7 GSM ET100 (EQ100) (6 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0	0	0	0
Delay [ns]:	0	3200	6400	9600	12800	16000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100

A.2.8 GSM TU3 (12 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4	3	0	2,6	3	5
Delay [ns]:	0	100	300	500	800	1100
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3	3
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	7	5	6,5	8,6	11	10
Delay [ns]:	1300	1700	2300	3100	3200	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3	3

A.2.9 GSM TU50 (12 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4	3	0	2,6	3	5
Delay [ns]:	0	100	300	500	800	1100
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	7	5	6,5	8,6	11	10

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Delay [ns]:	1300	1700	2300	3100	3200	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.2.10 GSM HT100 (12 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	10	8	6	4	0	0
Delay [ns]:	0	100	300	500	700	1000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4	8	9	10	12	14
Delay [ns]:	1300	15000	15200	15700	17200	20000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100

A.2.11 GSM TI5

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0

	Path 1	Path 2
Delay [ns]:	0	400
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	5	5

A.3 NADC Standards

Path 2 should be placed in its own group (delay max. 40 000 ns).

A.3.1 NADC 8 (2 Path)

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	41200
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	8	8

A.3.2 NADC 50 (2 Path)

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	41200
LogNormal	off	off
Corr with	off	off

	Path 1	Path 2
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	50	50

A.3.3 NADC 100 (2 Path)

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	41200
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	100	100

A.4 PCN Standards

A.4.1 PCN TU1.5 (6 Path)

Same as GSM Tux

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	0	2	6	8	10
Delay [ns]:	0	200	500	1600	2300	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	1,5	1,5	1,5	1,5	1,5	1,5

A.4.2 PCN TU50 (6 Path)

Same as GSM TU50

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	0	2	6	8	10
Delay [ns]:	0	200	500	1600	2300	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.4.3 PCN HT100 (6 Path)

Same as GSM

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1,5	4,5	7,5	8	17,7
Delay [ns]:	0	100	300	500	15000	17200
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100

A.4.4 PCN RA130 (6 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rice	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	4	8	12	16	20
Delay [ns]:	0	100	200	300	400	500
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	6,47	0	0	0	0	0

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Freq Ratio:	0,7	0	0	0	0	0
Speed [km/h]:	130	130	130	130	130	130

A.4.5 PCN ET50 (EQ50) (6 Path)

Same as GSM

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0	0	0	0
Delay [ns]:	0	3200	6400	9600	12800	16000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.4.6 PCN ET60 (EQ60) (6 Path)

Same as GSM

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0	0	0	0
Delay [ns]:	0	3200	6400	9600	12800	16000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	60	60	60	60	60	60

A.4.7 PCN ET100 (EQ100) (6 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0	0	0	0
Delay [ns]:	0	3200	6400	9600	12800	16000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100

A.4.8 PCN TU1.5 (12 Path)

Same as GSM Tux

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4	3	0	2,6	3	5
Delay [ns]:	0	100	300	500	800	1100
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	1,5	1,5	1,5	1,5	1,5	1,5
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	7	5	6,5	8,6	11	10
Delay [ns]:	1300	1700	2300	3100	3200	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	1,5	1,5	1,5	1,5	1,5	1,5

A.4.9 PCN TU50 (12 Path)

Same as GSM

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4	3	0	2,6	3	5
Delay [ns]:	0	100	300	500	800	1100
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	7	5	6,5	8,6	11	10
Delay [ns]:	1300	1700	2300	3100	3200	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.4.10 PCN HT100 (12 Path)

Same as GSM

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	10	8	6	4	0	0

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Delay [ns]:	0	100	300	500	700	1000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4	8	9	10	12	14
Delay [ns]:	1300	15000	15200	15700	17200	20000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100

A.5 TETRA Standards

A.5.1 TETRA TU50 (2 Path)

EN300 392-2

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	22,3
Delay [ns]:	0	5000
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0

	Path 1	Path 2
Freq Ratio:	0	0
Speed [km/h]:	50	50

A.5.2 TETRA TU50 (6 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3.00	0	2.0	6.0	8.0	10.0
Delay [ns]:	0	0	0	0	0	0
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.5.3 TETRA BU50 (2 Path)

EN300 392-2

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	3
Delay [ns]:	0	5000
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	50	50

A.5.4 TETRA HT200 (2 Path)

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	8,6
Delay [ns]:	0	15000
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	200	200

A.5.5 TETRA HT200 (6 Path)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	2	4	7	6	12
Delay [ns]:	0	200	400	600	15000	17200
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	200.02	200.02	200.02	200.02	200.02	200.02

A.5.6 TETRA ET200 (4 Path)

EN300 392-2, Equalizer Test

Note:Path 3 and 4 should be placed in their own group (delay max. 40 000 ns)

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	10,2	16

	Path 1	Path 2	Path 3	Path 4
Delay [ns]:	0	11600	73200	99300
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	0	0	0	0
Freq Ratio:	0	0	0	0
Speed [km/h]:	200	200	200	200

A.5.7 TETRA DU 50 (1Path)

ETSI EN 300 396-2 V1.2.1

	Path 1
Profile [Type]	Rice
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	0,7
Speed [km/h]:	50

A.5.8 TETRA DR 50 (1Path)

ETSI EN 300 396-2 V1.2.1

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	50

A.6 3GPP Standards

VAx are typical fading profiles, with x representing the speed, such as VA3 represents 3 km/h.

These standards define a certain combination of channels with a specific doppler frequency. Basically, the maximum possible doppler frequency of a path is determined by the RF output frequency and the speed of the moving mobile receiver. However, if you change the RF frequency in a VAx standard, the doppler frequency remains the same, thus resulting in individual speed settings.

Refer also to chapter A.6.12, "3GPP Mobile VA3, 3GPP Mobile VA30, 3GPP Mobile VA120", on page 210 for VAx fading profiles.

A.6.1 3GPP Case 1 (UE/BS)

Table 1-7: 3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2 and 3GPP TS 25.141 V6.3.0 (2003-09), annex D.2

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	10
Delay [ns]:	0	976
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	3	3

A.6.2 3GPP Case 2 (UE/BS)

Table 1-8: 3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2 and 3GPP TS 25.141 V6.3.0 (2003-09), annex D.2

	Path 1	Path 2	Path 3
Profile [Type]	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	0
Delay [ns]:	0	976	20000
LogNormal	off	Off	off
Corr with	off	Off	off
Power Ratio [dB]:	0	0	0

	Path 1	Path 2	Path 3
Freq Ratio:	0	0	0
Speed [km/h]:	3	3	3

A.6.3 3GPP Case 3 (UE/BS)

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2 and 3GPP TS 25.141 V6.3.0 (2003-09), annex D.2

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	3	6	9
Delay [ns]:	0	260	521	781
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	0	0	0	0
Freq Ratio:	0	0	0	0
Speed [km/h]:	120	120	120	120

A.6.4 3GPP Case 4 (UE)

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	976
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	3	3

A.6.5 3GPP Case 5 (UE)

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	10
Delay [ns]:	0	976
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	50	50

A.6.6 3GPP Case 6 (UE) and Case 4 (BS)

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2 and 3GPP TS 25.141 V6.3.0 (2003-09), annex D.2

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	3	6	9
Delay [ns]:	0	260	521	781
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	0	0	0	0
Freq Ratio:	0	0	0	0
Speed [km/h]:	250	250	250	250

A.6.7 3GPP Mobile Case 7 (UE-Sector)

Table 1-9: 3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	4.3	6.6	2	7	7.5
Delay [ns]:	0	260	1040	4690	7290	14580
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	50	50	50	50	50	50

A.6.8 3GPP Mobile Case 7 (UE-Beam)

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2

	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0.3	0.9
Delay [ns]:	4690	7290	14580
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0	0	0
Speed [km/h]:	50	50	50

A.6.9 3GPP Mobile Case 8 (UE, CQI)

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2, Table B.1C;

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	10
Delay [ns]:	0	976
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	30	30

A.6.10 3GPP Mobile PA3

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2, ITU Pedestrian A (HSDPA)

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	9.7	19.2	22.8
Delay [ns]:	0	110	190	410
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	0	0	0	0
Freq Ratio:	0	0	0	0
Speed [km/h]:	3	3	3	3

A.6.11 3GPP Mobile PB3

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2, ITU Pedestrian B (HSDPA)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0.9	4.9	8	7.8	23.9
Delay [ns]:	0	200	800	1200	2300	3700
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3	3

A.6.12 3GPP Mobile VA3, 3GPP Mobile VA30, 3GPP Mobile VA120

Table 1-10: 3GPP TS 25.101 V6.2.0 (2003-09), annex B2.2, ITU vehicular A (HSDPA)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1	9	10	15	20
Delay [ns]:	0	310	710	1090	1730	2510
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	3 | 30 | 120 [1)]	3 | 30 | 120 [1)]	3 | 30 | 120 [1)]	3 | 30 | 120 [1)]	3 | 30 | 120 [1)]	3 | 30 | 120 [1)]

[1)] Speed of the respective standard VAx: VA3 = 3 km/h, VA30 = 30 km/h and VA120 = 120 km/h.

A.6.13 3GPP MBSFN Propagation Channel Profile (18 Path)

Table 1-11: 3GPP 3GPP TS 36.521-1 respectivelly TS36.101 V9.8.0

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1.5	1.4	3.6	0.6	7.0
Delay [ns]:	0	30	150	310	370	1090
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Frequency [Hz]: *	3	3	3	3	3	3

Table 1-12: 3GPP 3GPP TS 36.521-1 respectivelly TS36.101 V9.8.0 (Cont.)

	Path 7	Path 8	Path 9	Path 10	Path 11	Path 12
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	10.0	11.5	11.4	13.6	10.6	17.0
Delay [ns]:	12490	12520	12640	12800	12860	13580
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Frequency [Hz]: *	3	3	3	3	3	3

Table 1-13: 3GPP 3GPP TS 36.521-1 respectivelly TS36.101 V9.8.0 (Cont.)

	Path 13	Path 14	Path 15	Path 16	Path 17	Path 18
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	20.0	21.5	21.4	23.6	20.6	27.0
Delay [ns]:	27490	27520	27640	27800	27860	28580
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Frequency [Hz]: *	3	3	3	3	3	3

A.6.14 3GPP Birth Death

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.4

	Path 1	Path 2
Profile [Type]	Static	Static
Loss [dB]:	0	0
Delay [ns]:	0…10us	0…10us
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	1	1
Speed [km/h]:	0	0

Dwell: 191ms

(Mean)-Offset: 5 us

A.6.15 3GPP TUx

Table 1-14: 3GPP TS 25.943 V5.1.0 (2002-06)

	Path 1	Path 2	Path 3	Path 4	Path 5
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	7.6	10.1	10.2	5.7	16.3
Delay [ns]:	217	512	514	0	1230
LogNormal	off	off	off	off	off

	Path 1	Path 2	Path 3	Path 4	Path 5
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Freq Ratio:	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3

Table 1-15: 3GPP TS 25.943 V5.1.0 (2002-06) (Cont.)

	Path 6	Path 7	Path 8	Path 9	Path 10
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	10.2	11.5	13.4	21.5	21.6
Delay [ns]:	517	674	882	1820	1840
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Freq Ratio:	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3

Table 1-16: 3GPP TS 25.943 V5.1.0 (2002-06) (Cont.)

	Path 11	Path 12	Path 13	Path 14	Path 15
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	16.9	17.1	17.4	22.1	22.6
Delay [ns]:	1287	1311	1349	1880	1940
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Freq Ratio:	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3

Table 1-17: 3GPP TS 25.943 V5.1.0 (2002-06) (Cont.)

	Path 16	Path 17	Path 18	Path 19	Path 20
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	19	19	19.8	23.5	24.3
Delay [ns]:	1533	1535	1622	2050	2140
LogNormal	off	off	off	off	off

	Path 16	Path 17	Path 18	Path 19	Path 20
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Freq Ratio:	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3

A.6.16 3GPP HTx

Table 1-18: 3GPP TS 25.943 V5.1.0 (2002-06)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6	Path 7	Path 8	Path 9	Path 10
Profile [Type]	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh
Loss [dB]:	8.9	10.2	11.5	3.6	17.6	11.8	12.7	13	25.8	26.2
Delay [ns]:	356	441	528	0	15000	546	609	625	16880	16980
Log-Normal	off	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100	100	100	100	100

Table 1-19: 3GPP TS 25.943 V5.1.0 (2002-06) (Cont.)

	Path 11	Path 12	Path 13	Path 14	Path 15	Path 16	Path 17	Path 18	Path 19	Path 20
Profile [Type]	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh	Ray-leigh
Loss [dB]:	16.2	17.3	17.7	29	29.9	22.7	24.1	25.8	30	30.7
Delay [ns]:	842	916	941	17620	17830	16172	16492	16876	17850	18020
Log-Normal	off	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off	off

	Path 11	Path 12	Path 13	Path 14	Path 15	Path 16	Path 17	Path 18	Path 19	Path 20
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0	0
Speed [km/h]:	100	100	100	100	100	100	100	100	100	100

A.6.17 3GPP RAx

Table 1-20: 3GPP TS 25.943 V5.1.0 (2002-06)

	Path 1	Path 2	Path 3	Path 4	Path 5
Profile [Type]	Pure Dop	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	5.2	6.4	8.4	9.3	10
Delay [ns]:	0	42	101	129	149
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Freq Ratio:	0.7	0	0	0	0
Speed [km/h]:	250	250	250	250	250

Table 1-21: 3GPP TS 25.943 V5.1.0 (2002-06) (Cont.)

	Path 6	Path 7	Path 8	Path 9	Path 10
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	13.1	15.3	18.5	20.4	22.4
Delay [ns]:	245	312	410	469	528
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Freq Ratio:	0	0	0	0	0
Speed [km/h]:	250	250	250	250	250

A.6.18 3GPP Birth Death

3GPP TS 25.101 V6.2.0 (2003-09), annex B2.4

	Path 1	Path 2
Profile [Type]	Static	Static
Loss [dB]:	0	0
Delay [ns]:	0…10us	0…10us
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	1	1
Speed [km/h]:	0	0

Dwell: 191ms

(Mean)-Offset: 5 us

A.6.19 Reference + Moving Channel

See chapter A.15.1, "Reference + Moving Channel", on page 252.

A.6.20 HST1 Open Space, HST1 Open Space (DL+UL)

See chapter A.14.1, "HST1 Open Space, HST1 Open Space (DL+UL)", on page 250.

A.6.21 HST2 Tunnel Leaky Cable

See chapter A.14.2, "HST2 Tunnel Leaky Cable, HST2 Tunnel Leaky Cable (DL+UL)", on page 251.

A.6.22 HST3 Tunnel Multi Antennas, HST3 Tunnel Multi Antennas (DL+UL)

See chapter A.14.3, "HST3 Tunnel Multi Antennas, HST3 Tunnel Multi Antennas (DL +UL)", on page 251.

A.7 WLAN Standards

A.7.1 WLAN / HyperLan/2 Model A

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6	Path 7	Path 8	Path 9
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0,9	1,7	2,6	3,5	4,3	5,2	6,1	6,9
Delay [ns]:	0	10	20	30	40	50	60	70	80
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8
	Path 10	**Path 11**	**Path 12**	**Path 13**	**Path 14**	**Path 15**	**Path 16**	**Path 17**	**Path 18**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	7,8	4,7	7,3	9,9	12,5	13,7	18	22,4	26,7
Delay [ns]:	90	110	140	170	200	240	290	340	390
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8

Corresp. to a typical office environment for NLOS conditions and an average rms delay spread of 50ns

A.7.2 WLAN / HyperLan/2 Model B

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6	Path 7	Path 8	Path 9
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	2,6	3	3,5	3,9	0	1,3	2,6	3,9	3,4
Delay [ns]:	0	10	20	30	50	80	110	140	180
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8
	Path 10	**Path 11**	**Path 12**	**Path 13**	**Path 14**	**Path 15**	**Path 16**	**Path 17**	**Path 18**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	5,6	7,7	9,9	12,1	14,3	15,4	18,4	20,7	24,6
Delay [ns]:	230	280	330	380	430	490	560	640	730
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8

Corresp. to a typical large open space and office environments for NLOS conditions and an average rms delay spread of 100ns

A.7.3 WLAN / HyperLan/2 Model C

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6	Path 7	Path 8	Path 9
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3,3	3,6	3,9	4,2	0	0,9	1,7	2,6	1,5
Delay [ns]:	0	10	20	30	50	80	110	140	180
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8
	Path 10	**Path 11**	**Path 12**	**Path 13**	**Path 14**	**Path 15**	**Path 16**	**Path 17**	**Path 18**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	4,4	5,9	5,3	7,9	9,4	13,2	16,3	21,2
Delay [ns]:	230	280	330	400	490	600	730	880	1050
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8

A.7.4 WLAN / HyperLan/2 Model D

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6	Path 7	Path 8	Path 9
Profile [Type]	Rice	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	10	10,3	10,6	6,4	7,2	8,1	9	7,9
Delay [ns]:	0	10	20	30	50	80	110	140	180
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	10	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8
	Path 10	**Path 11**	**Path 12**	**Path 13**	**Path 14**	**Path 15**	**Path 16**	**Path 17**	**Path 18**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	9,4	10,8	12,3	11,7	14,3	15,8	19,6	22,7	27,6
Delay [ns]:	230	280	330	400	490	600	730	880	1050
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8

Corresponds to a typical office environment for "LOS" conditions. A 10db spike at 0 delay has been added resulting in an average rms delay spread of 140ns

A.7.5 WLAN / HyperLan/2 Model E

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6	Path 7	Path 8	Path 9
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	4,9	5,1	5,2	0,8	1,3	1,9	0,3	1,2	2,1
Delay [ns]:	0	10	20	40	70	100	140	190	240
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8
	Path 10	**Path 11**	**Path 12**	**Path 13**	**Path 14**	**Path 15**	**Path 16**	**Path 17**	**Path 18**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1,9	2,8	5,4	7,3	10,6	13,4	17,4	20,9
Delay [ns]:	320	430	560	710	880	1070	1280	1510	1760
LogNor-mal	off	off	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0	0	0
Speed [km/h]:	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8	10,8

Corresponds to a typical large open space environment for NLOS conditions and an average rms delay spread of 250ns

A.8 DAB Standards

A.8.1 DAB RA (4Tabs)

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Rice	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	2	10	20
Delay [ns]:	0	200	400	600
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:		0	0	0
Freq Ratio:	0	0	0	0
Speed [km/h]:	120	120	120	120

Tap 2: S(d) = 0,1 +/- 0,02

A.8.2 DAB RA (6 Tabs)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rice	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	4	8	12	16	20
Delay [ns]:	0	100	200	300	400	500
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:		0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	120	120	120	120	120	120

A.8.3 DAB TU (12 Tabs)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Gaus1	Gaus1
Loss [dB]:	4	3	0	2,6	3	5
Delay [ns]:	0	100	300	500	800	1100
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	25	25	25	25	25	25
	Path 7	**Path 8**	**Path 9**	**Path 10**	**Path 11**	**Path 12**
Profile [Type]	Gaus1	Gaus1	Gaus2	Gaus2	Gaus2	Gaus2
Loss [dB]:	7	5	6,5	8,6	11	10
Delay [ns]:	1300	1700	2300	3100	3200	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	25	25	25	25	25	25

Tap 6: S(d) = 1,0 +/- 0,1

A.8.4 DAB TU (6 Tabs)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Gaus1	Gaus2	Gaus2
Loss [dB]:	3	0	2	6	8	10
Delay [ns]:	0	200	500	1600	2300	5000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	25	25	25	25	25	25

Tap 3: S(d) = 1,0 +/- 0,1

A.8.5 DAB SFN (VHF)

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6	Path 7
Profile [Type]	Rayleigh	GausDAB	GausDAB	GausDAB	GausDAB	GausDAB	GausDAB
Loss [dB]:	0	13	18	22	26	31	32
Delay [ns]:	0	100000	220000	290000	385000	480000	600000
LogNor-mal	off	off	off	off	off	off	off
Corr with	off	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0	0
Speed [km/h]:	60	60	60	60	60	60	60

Needs both Fading Boards combined, i.e. Signal Routing "A->A(max paths) || B->B(unfaded)" or "A->A(unfaded) || B->B(max paths)".

Do not use Group 5.

A.9 WIMAX Standards

A.9.1 SUI 1 (omni ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	15	20

	Path 1	Path 2	Path 3
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	6,0206	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K-fact. = 4 ->> 10lg4 = 6,02

A.9.2 SUI 1 (omni ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	15	20
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	13,0103	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

A.9.3 SUI 1 (30° ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	21	32
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	12,0412	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

A.9.4 SUI 1 (30° ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	21	32
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	18,57332	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K-fact. = 72

A.9.5 SUI 2 (omni ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	12	15
Delay [ns]:	0	400	1100
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	3,0103	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=2

A.9.6 SUI 2 (omni ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	12	15
Delay [ns]:	0	400	1100
LogNormal	off	off	off
Corr with	off	off	off

	Path 1	Path 2	Path 3
Power Ratio [dB]:	10,41393	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

A.9.7 SUI 2 (30° ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	18	27
Delay [ns]:	0	400	1100
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	9,0309	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=8

A.9.8 SUI 2 (30° ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	18	27
Delay [ns]:	0	400	1100
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	15,56303	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=36

A.9.9 SUI 3 (omni ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	5	10
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

A.9.10 SUI 3 (omni ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	5	10
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	8,45098	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=7

A.9.11 SUI 3 (30° ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	11	22
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	4,771213	0	0

	Path 1	Path 2	Path 3
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=3

A.9.12 SUI 3 (30° ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	11	22
Delay [ns]:	0	400	900
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	12,78754	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=19

A.9.13 SUI 4 (omni ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	4	8
Delay [ns]:	0	1500	4000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=0 (no Rice-component)

A.9.14 SUI 4 (omni ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	4	8
Delay [ns]:	0	1500	4000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=1

A.9.15 SUI 4 (30° ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	10	20
Delay [ns]:	0	400	1100
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=1

A.9.16 SUI 4 (30° ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	10	20
Delay [ns]:	0	400	1100
LogNormal	off	off	off
Corr with	off	off	off

	Path 1	Path 2	Path 3
Power Ratio [dB]:	6,9897	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=5

A.9.17 SUI 5 (omni ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	5	10
Delay [ns]:	0	4000	10000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=0 (no Rice-component)

A.9.18 SUI 5 (omni ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	5	10
Delay [ns]:	0	4000	10000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=0 (no Rice-component)

A.9.19 SUI 5 (omni ant., 50%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	5	10
Delay [ns]:	0	4000	10000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	3,0103	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=2

A.9.20 SUI 5 (30° ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	11	22
Delay [ns]:	0	4000	10000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=0 (no Rice-component)

A.9.21 SUI 5 (30° ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	11	22
Delay [ns]:	0	4000	10000
LogNormal	off	off	off
Corr with	off	off	off

	Path 1	Path 2	Path 3
Power Ratio [dB]:	3,0103	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=2

A.9.22 SUI 5 (30° ant., 50%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	11	22
Delay [ns]:	0	4000	10000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	8,45098	0	0
Freq Ratio:	0,2	0,15	0,25
Speed [km/h]:	0.03	0.02	0.03

K=7

A.9.23 SUI 6 (omni ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	10	14
Delay [ns]:	0	14000	20000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=0 (no Rice-component)

A.9.24 SUI 6 (omni ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	10	14
Delay [ns]:	0	14000	20000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=0 (no Rice-component)

A.9.25 SUI 6 (omni ant., 50%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	10	14
Delay [ns]:	0	14000	20000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=1

A.9.26 SUI 6 (30° ant., 90%)

	Path 1	Path 2	Path 3
Profile [Type]	WMDopp	WMDopp	WMDopp
Loss [dB]:	0	16	26
Delay [ns]:	0	14000	20000
LogNormal	off	off	off
Corr with	off	off	off

	Path 1	Path 2	Path 3
Power Ratio [dB]:	0	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=0 (no Rice-component)

A.9.27 SUI 6 (30° ant., 75%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	16	26
Delay [ns]:	0	14000	20000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	3,0103	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=2

A.9.28 SUI 6 (30° ant., 50%)

	Path 1	Path 2	Path 3
Profile [Type]	WMRice	WMDopp	WMDopp
Loss [dB]:	0	16	26
Delay [ns]:	0	14000	20000
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	6,9897	0	0
Freq Ratio:	0,4	0,3	0,5
Speed [km/h]:	0.05	0.04	0.06

K=5

A.9.29 ITU OIP-A

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	9,7	19,2	22,8
Delay [ns]:	0	110	190	410
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	0	0	0	0
Freq Ratio:	0	0	0	0
Speed [km/h]:	-	-	-	-

A.9.30 ITU OIP-B

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0,9	4,9	8	7,8	23,9
Delay [ns]:	0	200	800	1200	2300	3700
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	-	-	-	-	-	-

A.9.31 ITU V-A 60

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1	9	10	15	20
Delay [ns]:	0	310	710	1090	1730	2510
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	60	60	60	60	60	60

A.9.32 ITU V-A 120

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1	9	10	15	20
Delay [ns]:	0	310	710	1090	1730	10000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Freq Ratio:	0	0	0	0	0	0
Speed [km/h]:	120	120	120	120	120	120

A.10 LTE Standards

A.10.1 CQI 5Hz

CQI Tests according to 3GPP 36.521.1 Version 9.1.0, B2.4

	Path 1	Path 2
Profile [Type]	Const. Phase	Pure Doppler
Loss [dB]:	0	0
Delay [ns]:	0	450
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0

	Path 1	Path 2
Freq Ratio:	0	0
Speed [Hz]:	0	5 Hz

A.10.2 EPA (Extended Pedestrian A)

Table 1-22: 3GPP TR36.803

	Path 1	Path 2	Path 3	Path 4	Path 5
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1	2	3	8
Delay [ns]:	0	30	70	90	110
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Frequency [Hz]:	5	5	5	5	5
	Path 6	**Path 7**	**Path 8**	**Path 9**	**Path 10**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	17.2	20.8			
Delay [ns]:	190	410			
LogNormal	off	off			
Corr with	off	off			
Power Ratio [dB]:	0	0			
Frequency [Hz]:	5	5			

A.10.3 EVA (Extended Vehicular A)

Table 1-23: 3GPP TR36.803

	Path 1	Path 2	Path 3	Path 4	Path 5
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1.5	1.4	3.6	0.6
Delay [ns]:	0	30	150	310	370
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off

	Path 1	Path 2	Path 3	Path 4	Path 5
Power Ratio [dB]:	0	0	0	0	0
Frequency [Hz]: *					
	Path 6	**Path 7**	**Path 8**	**Path 9**	**Path 10**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	9.1	7	12	16.9	
Delay [ns]:	710	1090	1730	2510	
LogNormal	off	off	off	off	
Corr with	off	off	off	off	
Power Ratio [dB]:	0	0	0	0	
Frequency [Hz]: *					

* Possible frequency values are 5 Hz or 70 Hz

A.10.4 ETU (Extended Typical Urban)

Table 1-24: 3GPP TR36.803

	Path 1	Path 2	Path 3	Path 4	Path 5
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	1	1	1	0	0
Delay [ns]:	0	50	120	200	230
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Frequency [Hz]: *					
	Path 6	**Path 7**	**Path 8**	**Path 9**	**Path 10**
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	3	5	7	
Delay [ns]:	500	1600	2300	5000	
LogNormal	off	off	off	off	
Corr with	off	off	off	off	

	Path 1	Path 2	Path 3	Path 4	Path 5
Power Ratio [dB]:	0	0	0	0	
Frequency [Hz]: *					

* Possible frequency values are 70 Hz or 300 Hz

A.10.5 MBSFN Propagation Channel Profile (5 Hz)

See chapter A.6.13, "3GPP MBSFN Propagation Channel Profile (18 Path)", on page 211.

* All fading paths use "Frequency = 5 Hz" and "Speed = 5.4 km/h".

A.10.6 HST1 Open Space

See chapter A.14.1, "HST1 Open Space, HST1 Open Space (DL+UL)", on page 250.

A.10.7 HST3 Tunnel Multi Antennas

See chapter A.14.3, "HST3 Tunnel Multi Antennas, HST3 Tunnel Multi Antennas (DL +UL)", on page 251.

A.10.8 ETU 200Hz Moving

See chapter A.15.2, "ETU 200Hz Moving (UL Timing Adjustment, Scenario 1)", on page 252.

A.10.9 Pure Doppler Moving

Seechapter A.15.3, "Pure Doppler Moving (UL Timing Adjustment, Scenario 2)", on page 253.

A.11 LTE-MIMO Standards

A.11.1 EPA (Extended Pedestrian A)

See chapter A.10.2, "EPA (Extended Pedestrian A)", on page 238.

A.11.2 EVA (Extended Vehicular A)

See chapter A.10.3, "EVA (Extended Vehicular A)", on page 238.

A.11.3 ETU (Extended Typical Urban)

See chapter A.10.4, "ETU (Extended Typical Urban)", on page 239.

A.11.4 MIMO Parameter

Table 1-25: R-High

real	imaginary	real	imaginary	real	imaginary	real	imaginary
1	0	-0.4193	0.24	0.5297	0.7013	-0.3904	-0.1669
-0.4193	-0.24	1	0	-0.0538	-0.4212	0.5297	0.7013
0.5297	-0.7013	-0.0538	0.4212	1	0	-0.4193	0.24
-0.3904	0.1669	0.5297	-0.7013	-0.4193	-0.24	1	0

Table 1-26: R-Medium

real	imaginary	real	imaginary	real	imaginary	real	imaginary
1	0	0	0	0.7264	0	0	0
0	0	1	0	0	0	-0.7264	0
0.7264	0	0	0	1	0	0	0
0	0	-0.7264	0	0	0	1	0

Table 1-27: R-Low

real	imaginary	real	imaginary	real	imaginary	real	imaginary
1	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0
0	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0

The MIMO correlation matrices for the high, medium and low antenna correlation for the 1x2, 2x2 and 4x2 MIMO configurations are calculated according to 3GPP TS36.101, annex B2.3.2.

A.11.5 HST3 Tunnel Multi Antennas

See chapter A.14.3, "HST3 Tunnel Multi Antennas, HST3 Tunnel Multi Antennas (DL +UL)", on page 251.

A.12 WIMAX-MIMO Standards

A.12.1 ITU Pedestrian B 3

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0,9	4,9	8	7,8	23,9
Delay [ns]:	0	200	800	1200	2300	3700
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Speed [km/h]:	3	3	3	3	3	3

Table 1-28: MIMO Parameter - High Correlation

	real	imagi-nary	real	imagi-nary	real	imagi-nary	real	imagi-nary
TAP 1	1	0	-0,1468	0,4156	0,0303	0,7064	-0,298	-0,0911
	-0,1468	-0,4156	1	0	0,28913	-0,1163	0,0303	0,7064
	0,0303	-0,7064	0,28913	0,11629	1	0	-0,1468	0,4156
	-0,298	0,09111	0,0303	-0,7064	-0,1468	-0,4156	1	0
TAP 2	1	0	-0,4467	0,4227	-0,4007	-0,6073	0,4357	0,10191
	-0,4467	-0,4227	1	0	-0,0777	0,44066	-0,4007	-0,6073
	-0,4007	0,6073	-0,0777	-0,4407	1	0	-0,4467	0,4227
	0,4357	-0,1019	-0,4007	0,6073	-0,4467	-0,4227	1	0
TAP 3	1	0	-0,2906	0,4347	-0,6664	0,262	0,07976	-0,3658
	-0,2906	-0,4347	1	0	0,30755	0,21355	-0,6664	0,262
	-0,6664	-0,262	0,30755	-0,2135	1	0	-0,2906	0,4347
	0,07976	0,36582	-0,6664	-0,262	-0,2906	-0,4347	1	0
TAP 4	1	0	-0,4273	0,4259	-0,6522	0,2088	0,18976	-0,367
	-0,4273	-0,4259	1	0	0,36761	0,18855	-0,6522	0,2088
	-0,6522	-0,2088	0,36761	-0,1886	1	0	-0,4273	0,4259
	0,18976	0,36699	-0,6522	-0,2088	-0,4273	-0,4259	1	0
TAP 5	1	0	-0,7026	-0,3395	-0,5378	-0,4866	0,21266	0,52447

	real	imagi-nary	real	imagi-nary	real	imagi-nary	real	imagi-nary
	-0,7026	0,3395	1	0	0,54306	0,1593	-0,5378	-0,4866
	-0,5378	0,4866	0,54306	-0,1593	1	0	-0,7026	-0,3395
	0,21266	-0,5245	-0,5378	0,4866	-0,7026	0,3395	1	0
TAP 6	1	0	-0,45	0,4222	-0,4564	-0,5655	0,44413	0,06178
	-0,45	-0,4222	1	0	-0,0334	0,44717	-0,4564	-0,5655
	-0,4564	0,5655	-0,0334	-0,4472	1	0	-0,45	0,4222
	0,44413	-0,0618	-0,4564	0,5655	-0,45	-0,4222	1	0

Table 1-29: MIMO Parameter - Medium Correlation

	real	imagi-nary	real	imagi-nary	real	imagi-nary	real	imagi-nary
TAP 1-TAP 6	1	0	0	0	0,7264	0	0	0
	0	0	1	0	0	0	-0,7264	0
	0,7264	0	0	0	1	0	0	0
	0	0	-0,7264	0	0	0	1	0

Table 1-30: MIMO Parameter - Low Correlation

	real	imagi-nary	real	imagi-nary	real	imagi-nary	real	imagi-nary
TAP 1	1	0	0	0	0,02201	0,51313	0	0
	0	0	1	0	0	0	-0,022	-0,5131
	0,02201	-0,5131	0	0	1	0	0	0
	0	0	-0,022	0,51313	0	0	1	0
TAP 2	1	0	0	0	-0,2911	-0,4411	0	0
	0	0	1	0	0	0	0,29107	0,44114
	-0,2911	0,44114	0	0	1	0	0	0
	0	0	0,29107	-0,4411	0	0	1	0
TAP 3	1	0	0	0	-0,4841	0,19032	0	0
	0	0	1	0	0	0	0,48407	-0,1903
	-0,4841	-0,1903	0	0	1	0	0	0
	0	0	0,48407	0,19032	0	0	1	0
TAP 4	1	0	0	0	-0,4738	0,15167	0	0
	0	0	1	0	0	0	0,47376	-0,1517
	-0,4738	-0,1517	0	0	1	0	0	0

	real	imagi-nary	real	imagi-nary	real	imagi-nary	real	imagi-nary
	0	0	0,47376	0,15167	0	0	1	0
TAP 5	1	0	0	0	-0,3907	-0,3535	0	0
	0	0	1	0	0	0	0,39066	0,35347
	-0,3907	0,35347	0	0	1	0	0	0
	0	0	0,39066	-0,3535	0	0	1	0
TAP 6	1	0	0	0	-0,3315	-0,4108	0	0
	0	0	1	0	0	0	0,33153	0,41078
	-0,3315	0,41078	0	0	1	0	0	0
	0	0	0,33153	-0,4108	0	0	1	0

A.12.2 ITU Vehicular A-60

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	1	9	10	15	20
Delay [ns]:	0	310	710	1090	1730	2510
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0	0
Speed [km/h]:	60	60	60	60	60	60

Table 1-31: MIMO Parameter - High Correlation

	real	imagi-nary	real	imagi-nary	real	imagi-nary	real	imagi-nary
TAP 1	1	0	-0,2366	0,4312	0,6883	0,1211	-0,2151	0,26814
	-0,2366	-0,4312	1	0	-0,1106	-0,3254	0,6883	0,1211
	0,6883	-0,1211	-0,1106	0,32545	1	0	-0,2366	0,4312
	-0,2151	-0,2681	0,6883	-0,1211	-0,2366	-0,4312	1	0
TAP 2	1	0	0,1388	0,2343	-0,3508	-0,5926	0,09016	-0,1644
	0,1388	-0,2343	1	0	-0,1875	-6E-05	-0,3508	-0,5926
	-0,3508	0,5926	-0,1875	6E-05	1	0	0,1388	0,2343
	0,09016	0,16445	-0,3508	0,5926	0,1388	-0,2343	1	0

	real	imagi-nary	real	imagi-nary	real	imagi-nary	real	imagi-nary
TAP 3	1	0	-0,6443	0,365	0,3884	-0,5604	-0,0457	0,50283
	-0,6443	-0,365	1	0	-0,4548	0,2193	0,3884	-0,5604
	0,3884	0,5604	-0,4548	-0,2193	1	0	-0,6443	0,365
	-0,0457	-0,5028	0,3884	0,5604	-0,6443	-0,365	1	0
TAP 4	1	0	-0,362	0,4331	0,1899	0,6795	-0,363	-0,1637
	-0,362	-0,4331	1	0	0,22555	-0,3282	0,1899	0,6795
	0,1899	-0,6795	0,22555	0,32822	1	0	-0,362	0,4331
	-0,363	0,16373	0,1899	-0,6795	-0,362	-0,4331	1	0
TAP 5	1	0	-0,7074	0,3372	-0,3933	-0,565	0,46874	0,26706
	-0,7074	-0,3372	1	0	0,0877	0,5323	-0,3933	-0,565
	-0,3933	0,565	0,0877	-0,5323	1	0	-0,7074	0,3372
	0,46874	-0,2671	-0,3933	0,565	-0,7074	-0,3372	1	0
TAP 6	1	0	-0,4405	0,4238	-0,4383	-0,58	0,43888	0,06974
	-0,4405	-0,4238	1	0	-0,0527	0,44124	-0,4383	-0,58
	-0,4383	0,58	-0,0527	-0,4412	1	0	-0,4405	0,4238
	0,43888	-0,0697	-0,4383	0,58	-0,4405	-0,4238	1	0

Table 1-32: MIMO Parameter - Medium Correlation

	real	imagi-nary	real	imagi-nary	real	imagi-nary	real	imagi-nary
TAP 1-TAP 6	1	0	0	0	0,7264	0	0	0
	0	0	1	0	0	0	-0,7264	0
	0,7264	0	0	0	1	0	0	0
	0	0	-0,7264	0	0	0	1	0

Table 1-33: MIMO Parameter - Low Correlation

	real	imagi-nary	real	imagi-nary	real	imagi-nary	real	imagi-nary
TAP 1	1	0	0	0	0,49998	0,08797	0	0
	0	0	1	0	0	0	-0,5	-0,088
	0,49998	-0,088	0	0	1	0	0	0
	0	0	-0,5	0,08797	0	0	1	0
TAP 2	1	0	0	0	-0,2548	-0,4305	0	0
	0	0	1	0	0	0	0,25482	0,43046

	real	imagi-nary	real	imagi-nary	real	imagi-nary	real	imagi-nary
	-0,2548	0,43046	0	0	1	0	0	0
	0	0	0,25482	-0,4305	0	0	1	0
TAP 3	1	0	0	0	0,28213	-0,4071	0	0
	0	0	1	0	0	0	-0,2821	0,40707
	0,28213	0,40707	0	0	1	0	0	0
	0	0	-0,2821	-0,4071	0	0	1	0
TAP 4	1	0	0	0	0,13794	0,49359	0	0
	0	0	1	0	0	0	-0,1379	-0,4936
	0,13794	-0,4936	0	0	1	0	0	0
	0	0	-0,1379	0,49359	0	0	1	0
TAP 5	1	0	0	0	-0,3907	-0,3535	0	0
	0	0	1	0	0	0	0,39066	0,35347
	-0,3907	0,35347	0	0	1	0	0	0
	0	0	0,39066	-0,3535	0	0	1	0
TAP 6	1	0	0	0	-0,3184	-0,4213	0	0
	0	0	1	0	0	0	0,31838	0,42131
	-0,3184	0,42131	0	0	1	0	0	0
	0	0	0,31838	-0,4213	0	0	1	0

A.13 1xEVDO Standards

According to 3GPP2 C.S0032-A v2.0

A.13.1 1xEVDO Chan. 1

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0

	Path 1	Path 2
Freq Ratio:	0	0
Speed [km/h]:	8	8

A.13.2 1xEVDO Chan. 1 (Bd. 5, 11)

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	15	15

A.13.3 1xEVDO Chan. 2

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	3

A.13.4 1xEVDO Chan. 2 (Bd. 5, 11)

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0
Delay [ns]:	0

	Path 1
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	6

A.13.5 1xEVDO Chan. 3

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	30

A.13.6 1xEVDO Chan. 3 (Bd. 5, 11)

	Path 1
Profile [Type]	Rayleigh
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	0
Speed [km/h]:	58

A.13.7 1xEVDO Chan. 4

	Path 1	Path 2	Path 3
Profile [Type]	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	3
Delay [ns]:	0	2000	14500
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0	0	0
Speed [km/h]:	100	100	100

A.13.8 1xEVDO Chan. 4 (Bd. 5, 11)

	Path 1	Path 2	Path 3
Profile [Type]	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	0	3
Delay [ns]:	0	2000	14500
LogNormal	off	off	off
Corr with	off	off	off
Power Ratio [dB]:	0	0	0
Freq Ratio:	0	0	0
Speed [km/h]:	192	192	192

A.13.9 1xEVDO Chan. 5

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0

	Path 1	Path 2
Freq Ratio:	0	0
Speed [km/h]:	0	0

A.13.10 1xEVDO Chan. 5 (Bd. 5, 11)

	Path 1	Path 2
Profile [Type]	Rayleigh	Rayleigh
Loss [dB]:	0	0
Delay [ns]:	0	2000
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	0	0
Speed [km/h]:	0	0

A.14 3GPP/LTE High Speed Train

A.14.1 HST1 Open Space, HST1 Open Space (DL+UL)

3GPP TS25.141, annex D.4A "High Speed Train" and 3GPP TS36.141, annex B.3 "High Speed Train"

The HST DL+UL standards consider the downlink and the uplink. That is, if a doppler shift occurs in the downlink, the mobile receiver synchronizes to that shifted frequency. The uplink to the base station then results in a doppler shift enlarged by a factor based on the sum of the DL and UL frequency.

	Path 1
Profile [Type]	Pure Doppler
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	-

	Path 1
Freq Ratio:	
Speed [km/h]:	350km/h
D_{min}	50m
D_s	1000m

A.14.2 HST2 Tunnel Leaky Cable, HST2 Tunnel Leaky Cable (DL+UL)

3GPP TS25.141, annex D.4A "High Speed Train"

The HST DL+UL standards consider the downlink and the uplink. That is, if a doppler shift occurs in the downlink, the mobile receiver synchronizes to that shifted frequency. The uplink to the base station then results in a doppler shift enlarged by a factor based on the sum of the DL and UL frequency.

	Path 1
Profile [Type]	Rice
Loss [dB]:	10
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Freq Ratio:	1
Speed [km/h]:	300km/h

A.14.3 HST3 Tunnel Multi Antennas, HST3 Tunnel Multi Antennas (DL+UL)

3GPP TS25.141, annex D.4A "High Speed Train" and 3GPP TS36.141, annex B.3A "High Speed Train"

The HST DL+UL standards consider the downlink and the uplink. That is, if a doppler shift occurs in the downlink, the mobile receiver synchronizes to that shifted frequency. The uplink to the base station then results in a doppler shift enlarged by a factor based on the sum of the DL and UL frequency.

	Path 1
Profile [Type]	Pure Doppler
Loss [dB]:	0

	Path 1
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	-
Freq Ratio:	
Speed [km/h]:	300km/h
D_{min}	2m
D_s	300m

A.15 3GPP/LTE Moving Propagation

A.15.1 Reference + Moving Channel

Table 1-34: 3GPP TS 25.101, annex B2.3

	Path 1	Path 2
Profile [Type]	Static	Static
Loss [dB]:	0	0
Delay [ns]:	0	1… 6us
LogNormal	off	off
Corr with	off	off
Power Ratio [dB]:	0	0
Freq Ratio:	1	1
Speed [km/h]:	0	0

Period: 157,0796s = 2*PI/0.04

(Mean)-Delay: 3.5µs

A.15.2 ETU 200Hz Moving (UL Timing Adjustment, Scenario 1)

Table 1-35: 3GPP TS36.141, annex B.4 "Moving Propagation Conditions"

	Path 1	Path 2	Path 3	Path 4	Path 5
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	1	1	1	0	0

	Path 1	Path 2	Path 3	Path 4	Path 5
Delay [ns]:	0	50	120	200	230
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Power Ratio [dB]:	0	0	0	0	0
Doppler [Hz]:					
Speed [km/h]:	120	120	120	120	120

	Path 6	Path 7	Path 8	Path 9
Profile [Type]	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	0	3	5	7
Delay [ns]:	500	1600	2300	5000
LogNormal	off	off	off	off
Corr with	off	off	off	off
Power Ratio [dB]:	0	0	0	0
Doppler [Hz]:				
Speed [km/h]:	120	120	120	120

Period: 157,0796s = 2*PI/0.04

Amplitude: 5us = 10us/2

A.15.3 Pure Doppler Moving (UL Timing Adjustment, Scenario 2)

Table 1-36: 3GPP TS36.141, annex B.4 "Moving Propagation Conditions"

	Path 1
Profile [Type]	Pure Doppler
Loss [dB]:	0
Delay [ns]:	0
LogNormal	off
Corr with	off
Power Ratio [dB]:	0
Doppler [Hz]:	
Speed [km/h]:	350

Period: 48,33s = 2*PI/0.13

Amplitude: 5µs = 10µs/2

A.16 SCME Channel Models for MIMO OTA

The SCME models define 6 clusters characterized by the delay, the AoA/AoD, AS and PAS shape.

The following antenna polarization and antenna pattern settings apply for all SCME models.

Antenna Settings	Polarization	Distance (d_a)	Antenna Pattern
Tx	Cross 45°	0	Dipole
Rx	Cross 90°	0	Isotropic

A.16.1 SCME Urban Micro-Cell Channel (UMi) 3 and 30 km/h

Tap	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Cluster	1			2		
Profile [Type]:	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	5.2	7	4.3	6.5	8.3
Delay [ns]:	0	5	10	285	290	295
Fine Delay required:	0	0	0	0	0	0
AoA [°]:	0.7			-13.2		
AoD [°]:	6.6			14.1		

Tap	Path 7	Path 8	Path 9	Path 10	Path 11	Path 12
Cluster	3			4		
Profile [Type]:	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	5.7	7.9	9.7	7.3	9.5	11.3
Delay [ns]:	205	210	215	660	665	670
Fine Delay required:	0	0	0	0	0	0
AoA [°]:	146.1			-30.5		
AoD [°]:	50.8			38.4		

Tap	Path 13	Path 14	Path 15	Path 16	Path 17	Path 18
Cluster	5			6		
Profile [Type]:	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	9	11.2	13	11.4	13.6	15.4
Delay [ns]:	805	810	815	925	930	935
Fine Delay required:	0	0	0	0	0	0
AoA [°]:	-11.4			-1.1		
AoD [°]:	6.7			40.3		

Delay Spread [ns]:	294
Cluster AS AoD / AS AoA [°]:	5 /35
Cluster PAS shape:	Laplacian
Total AS AoD / AS AoA [°]:	18.2 /67.8
Mobile speed [km/h] / Direction of travel [°]:	3, 30 /120
XPR[1] [dB]:	9

[1] XPR = cross polarization power ratio in the selected propagation channel

A.16.2 SCME Urban Macro-Cell Channel (UMa) 3 and 30 km/h

Tap	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Cluster	1			2		
Profile [Type]:	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	3	5.2	7	5.2	7.4	9.2
Delay [ns]:	0	5	10	360	365	370
Fine Delay required:	0	0	0	0	0	0
AoA [°]:	66			46		
AoD [°]:	82			81		

Tap	Path 7	Path 8	Path 9	Path 10	Path 11	Path 12
Cluster	3			4		
Profile [Type]:	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh

Tap	Path 7	Path 8	Path 9	Path 10	Path 11	Path 12
Loss [dB]:	4.7	6.9	8.7	8.2	10.4	12.2
Delay [ns]:	255	260	265	1040	1045	1050
Fine Delay required:	0	0	0	0	0	0
AoA [°]:	143			33		
AoD [°]:	80			99		

Tap	Path 13	Path 14	Path 15	Path 16	Path 17	Path 18
Cluster	5			6		
Profile [Type]:	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh	Rayleigh
Loss [dB]:	12.1	14.3	16.1	15.5	17.7	19.5
Delay [ns]:	2730	2735	2740	4600	4605	4610
Fine Delay required:	0	0	0	0	0	0
AoA [°]:	-91			-19		
AoD [°]:	102			107		

Delay Spread [ns]:	839.5
Cluster AS AoD / AS AoA [°]:	2 / 35
Cluster PAS shape:	Laplacian
Total AS AoD / AS AoA [°]:	7.8 / 62.6
Mobile speed [km/h] / Direction of travel [°]:	3, 30 / 120
XPR[1] [dB]:	9

[1] XPR = cross polarization power ratio in the selected propagation channel

A.17 Watterson Standards

A.17.1 Watterson I1

	Path 1	Path 2	Path 3	Path 4	Path 5
Profile [Type]	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson
Loss [dB]:	4.1	4.3	1.2	7.2	13.5

	Path 1	Path 2	Path 3	Path 4	Path 5
Delay [ns]:	40000	40000	40000	290000	1139000
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off
Freq. Spread:	0.0073	0.0318	0.0272	0.144	0.34
Freq Shift [Hz]:	0.0022	0.017	0.0094	0.0089	-0.167
Speed [km/h]:					

Tap 2: S(d) = 0,1 +/- 0,02

A.17.2 Watterson I2

	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Profile [Type]	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson
Loss [dB]:	4.1	5.5	1.7	5.9	17.6	12.6
Delay [ns]:	40000	40000	40000	290000	590000	1126000
LogNormal	off	off	off	off	off	off
Corr with	off	off	off	off	off	off
Freq. Spread:	0.0064	0.0084	0.0153	0.18	0.334	0.336
Freq Shift [Hz]:	-0.0008	0.0127	0.0071	0.0159	0.108	0.118
Speed [km/h]:						

Tap 3: S(d) = 0,1 +/- 0,02

A.17.3 Watterson I3

	Path 1	Path 2	Path 3	Path 4	Path 5
Profile [Type]	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson
Loss [dB]:	3.8	5.7	1.6	10.8	10.6
Delay [ns]:	445000	445000	445000	750000	750000
LogNormal	off	off	off	off	off
Corr with	off	off	off	off	off

	Path 1	Path 2	Path 3	Path 4	Path 5
Freq. Spread:	0.034	0.032	0.0658	0.0104	0.013
Freq Shift [Hz]:	0.0764	0.0134	0.0989	0.121	0.141
Speed [km/h]:					

	Path 6	Path 7	Path 8	Path 9
Profile [Type]	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson	Gauss-Watterson
Loss [dB]:	7.7	12.9	10.4	8.5
Delay [ns]:	750000	1088000	1088000	1088000
LogNormal	off	off	off	off
Corr with	off	off	off	off
Freq. Spread:	0.0229	0.0149	0.0206	0.0335
Freq Shift [Hz]:	0.131	0.121	0.151	0.014
Speed [km/h]:				

Tap 6: S(d) = 1,0 +/- 0,1

A.18 802.11n-SISO Standards

These fading profiles are implemented as the IEEE 802.11n-MIMO models, expect that:

- Correlation Path = Off
- Coefficient, % = 100
- Phase, deg = 0

See chapter A.19, "802.11n-MIMO Standards", on page 258.

A.19 802.11n-MIMO Standards

According to IEEE 801.11-03/940r4

Rx Antenna Distance = 1

Tx Antenna Distance = 0.5

Distribution = Laplace

Profile = Bell Shape tgn Indoor, exception Model F, Path 3 where the Profile = Bell Shape tgn Moving Vehicle

Speed = 1.2 km/h, exception Model F, Path 3 where Speed = 40 km/h

A.19.1 Model A

Tap:	Path 1
Cluster	
Profil [Typ]	Bell Shape tgn Indoor
Loss [dB]	0
Delay [ns]	0
AoA	45
AS (A)	40
AoD	45
AS (D)	40
Speed [km/h]	1.2

A.19.2 Model B

Tap:	Path 1	Path 2	Path 3		Path 4	
Cluster			1	2	1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	0	5.4	10.8	3.2	16.2	6.3
Delay [ns]:	0	10	20	20	30	30
AoA:	4.3	4.3	4.3	118.4	4.3	118.4
AS (A):	14.4	14.4	14.4	25.2	14.4	25.2
AoD:	225.1	225.1	225.1	106.5	225.1	106.5
AS (D):	14.4	14.4	14.4	25.4	14.4	25.4
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 5		Path 6	Path 7	Path 8	Path 9
Cluster	1	2				
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	21.7	9.4	12.5	15.6	18.7	21.8
Delay [ns]:	40	40	50	60	70	80

Tap:	Path 5		Path 6	Path 7	Path 8	Path 9
AoA:	4.3	118.4	118.4	118.4	118.4	118.4
AS (A):	14.4	25.2	25.2	25.2	25.2	25.2
AoD:	225.1	106.5	106.5	106.5	106.5	106.5
AS (D):	14.4	25.4	25.4	25.4	25.4	25.4
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

A.19.3 Model C

Tap:	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Cluster						
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	0	2.1	4.3	6.5	8.6	10.8
Delay [ns]:	0	10	20	30	40	50
AoA:	290.3	290.3	290.3	290.3	290.3	290.3
AS (A):	24.6	24.6	24.6	24.6	24.6	24.6
AoD:	13.5	13.5	13.5	13.5	13.5	13.5
AS (D):	24.7	24.7	24.7	24.7	24.7	24.7
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 7	Path 7	Path 8	Path 8	Path 9	Path 9
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	13	5	15.2	7.2	17.3	9.3
Delay [ns]:	60	60	70	70	80	80
AoA:	290.3	332.3	290.3	332.3	290.3	332.3
AS (A):	24.6	22.4	24.6	22.4	24.6	22.4
AoD:	13.5	56.4	13.5	56.4	13.5	56.4
AS (D):	24.7	22.5	24.7	22.5	24.7	22.5

Tap:	Path 7	Path 7	Path 8	Path 8	Path 9	Path 9
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 10	Path 10	Path 11	Path 12	Path 13	Path 14
Cluster	1	2				
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	19.5	11.5	13.7	15.8	18	20.2
Delay [ns]:	90	90	110	140	170	200
AoA:	290.3	332.3	332.3	332.3	332.3	332.3
AS (A):	24.6	22.4	22.4	22.4	22.4	22.4
AoD:	13.5	56.4	56.4	56.4	56.4	56.4
AS (D):	24.7	22.5	22.5	22.5	22.5	22.5
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

A.19.4 Model D

Tap:	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Cluster						
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	0	0.9	1.7	2.6	3.5	4.3
Delay [ns]:	0	10	20	30	40	50
AoA:	158.9	158.9	158.9	158.9	158.9	158.9
AS (A):	27.7	27.7	27.7	27.7	27.7	27.7
AoD:	332.1	332.1	332.1	332.1	332.1	332.1
AS (D):	27.4	27.4	27.4	27.4	27.4	27.4
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 7	Path 8	Path 9	Path 10	Path 11	
Cluster					1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	5.2	6.1	6.9	7.8	9	6.6
Delay [ns]:	60	70	80	90	110	110
AoA:	158.9	158.9	158.9	158.9	158.9	320.2
AS (A):	27.7	27.7	27.7	27.7	27.7	31.4
AoD:	332.1	332.1	332.1	332.1	332.1	49.3
AS (D):	27.4	27.4	27.4	27.4	27.4	32.1
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 12		Path 13		Path 14	
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	11.1	9.5	13.7	12.1	16.3	14.7
Delay [ns]:	140	140	170	170	200	200
AoA:	158.9	320.2	158.9	320.2	158.9	320.2
AS (A):	27.7	31.4	27.7	31.4	27.7	31.4
AoD:	332.1	49.3	332.1	49.3	332.1	49.3
AS (D):	27.4	32.1	27.4	32.1	27.4	32.1
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 15			Path 16		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	19.3	17.4	18.8	23.2	21.9	23.2
Delay [ns]:	240	240	240	290	290	290
AoA:	158.9	320.2	276.1	158.9	320.2	276.1

Tap:	Path 15			Path 16		
AS (A):	27.7	31.4	37.4	27.7	31.4	37.4
AoD:	332.1	49.3	275.9	332.1	49.3	275.9
AS (D):	27.4	32.1	36.8	27.4	32.1	36.8
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 17		Path 18
Cluster	2	3	
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	25.5	25.2	26.7
Delay [ns]:	340	340	390
AoA:	320.2	276.1	276.1
AS (A):	31.4	37.4	37.4
AoD:	49.3	275.9	275.9
AS (D):	32.1	36.8	36.8
Speed [km/h]	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace

A.19.5 Model E

Tap:	Path 1	Path 2	Path 3	Path 4	Path 5	
Cluster					1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Moving Vehicle	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	2.6	3	3.5	3.9	4.5	1.8
Delay [ns]:	0	10	20	30	50	50
AoA:	163.7	163.7	163.7	163.7	163.7	251.8
AS (A):	35.8	35.8	35.8	35.8	35.8	41.6
AoD:	105.6	105.6	105.6	105.6	105.6	293.1
AS (D):	36.1	36.1	36.1	36.1	36.1	42.5

Tap:	Path 1	Path 2	Path 3	Path 4	Path 5	
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 6		Path 7		Path 8	
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	5.6	3.2	6.9	4.5	8.2	5.8
Delay [ns]:	80	80	110	110	140	140
AoA:	163.7	251.8	163.7	251.8	163.7	251.8
AS (A):	35.8	41.6	35.8	41.6	35.8	41.6
AoD:	105.6	293.1	105.6	293.1	105.6	293.1
AS (D):	36.1	42.5	36.1	42.5	36.1	42.5
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 9			Path 10		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	9.8	7.1	7.9	11.7	9.9	9.6
Delay [ns]:	180	180	180	230	230	230
AoA:	163.7	251.8	80	163.7	251.8	80
AS (A):	35.8	41.6	37.4	35.8	41.6	37.4
AoD:	105.6	293.1	61.9	105.6	293.1	61.9
AS (D):	36.1	42.5	38	36.1	42.5	38
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 11			Path 12		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	13.9	10.3	14.2	16.1	14.3	13.8
Delay [ns]:	280	280	280	330	330	330
AoA:	163.7	251.8	80	163.7	251.8	80
AS (A):	35.8	41.6	37.4	35.8	41.6	37.4
AoD:	105.6	293.1	61.9	105.6	293.1	61.9
AS (D):	36.1	42.5	38	36.1	42.5	38
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 13			Path 14		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	18.3	14.7	18.6	20.5	18.7	18.1
Delay [ns]:	380	380	380	430	430	430
AoA:	163.7	251.8	80	163.7	251.8	80
AS (A):	35.8	41.6	37.4	35.8	41.6	37.4
AoD:	105.6	293.1	61.9	105.6	293.1	61.9
AS (D):	36.1	42.5	38	36.1	42.5	38
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 15				Path 16		Path 17	Path 18
Cluster	1	2	3	4	2	4	4	4
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	22.9	19.9	22.8	20.6	22.4	20.5	20.7	24.6
Delay [ns]:	490	490	490	490	560	560	640	730

Tap:	Path 15				Path 16		Path 17	Path 18
AoA:	163.7	251.8	80	182	251.8	182	182	182
AS (A):	35.8	41.6	37.4	40.3	41.6	40.3	40.3	40.3
AoD:	105.6	293.1	61.9	275.7	293.1	275.7	275.7	275.7
AS (D):	36.1	42.5	38	38.7	42.5	38.7	38.7	38.7
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Distribu-tion	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

A.19.6 Model F

Tap:	Path 1	Path 2	Path 3	Path 4	Path 5	
Cluster					1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	3.3	3.6	3.9	4.2	4.6	1.8
Delay [ns]:	0	10	20	30	50	50
AoA:	315.1	315.1	315.1	315.1	315.1	180.4
AS (A):	48	48	48	48	48	55
AoD:	56.2	56.2	56.2	56.2	56.2	183.7
AS (D):	41.6	41.6	41.6	41.6	41.6	55.2
Speed [km/h]	1.2	1.2	40	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 6		Path 7		Path 8	
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	5.3	2.8	6.2	3.5	7.1	4.4
Delay [ns]:	80	80	110	110	140	140
AoA:	315.1	180.4	315.1	180.4	315.1	180.4
AS (A):	48	55	48	55	48	55
AoD:	56.2	183.7	56.2	183.7	56.2	183.7
AS (D):	41.6	55.2	41.6	55.2	41.6	55.2

Tap:	Path 6		Path 7		Path 8	
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 9			Path 10		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	8.2	5.3	5.7	9.5	7.4	6.7
Delay [ns]:	180	180	180	230	230	230
AoA:	315.1	180.4	74.7	315.1	180.4	74.7
AS (A):	48	55	42	48	55	42
AoD:	56.2	183.7	153	56.2	183.7	153
AS (D):	41.6	55.2	47.4	41.6	55.2	47.4
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 11			Path 12		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	11	7	10.4	12.5	10.3	9.6
Delay [ns]:	280	280	280	330	330	330
AoA:	315.1	180.4	74.7	315.1	180.4	74.7
AS (A):	48	55	42	48	55	42
AoD:	56.2	183.7	153	56.2	183.7	153
AS (D):	41.6	55.2	47.4	41.6	55.2	47.4
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2
Distribu-tion	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 13				Path 14			
Cluster	1	2	3	4	1	2	3	4
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	14.3	10.4	14.1	8.8	16.7	13.8	12.7	13.3
Delay [ns]:	400	400	400	400	490	490	490	490
AoA:	315.1	180.4	74.7	251.5	315.1	180.4	74.7	251.5
AS (A):	48	55	42	28.6	48	55	42	28.6
AoD:	56.2	183.7	153	112.5	56.2	183.7	153	112.5
AS (D):	41.6	55.2	47.4	27.2	41.6	55.2	47.4	27.2
Speed [km/h]	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Distribu-tion	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 15				
Cluster	1	2	3	4	5
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	19.9	15.7	18.5	18.7	12.9
Delay [ns]:	600	600	600	600	600
AoA:	315.1	180.4	74.7	251.5	68.5
AS (A):	48	55	42	28.6	30.7
AoD:	56.2	183.7	153	112.5	291
AS (D):	41.6	55.2	47.4	27.2	33
Speed [km/h]	1.2	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 16		Path 17	Path 18
Cluster	2	5	6	6
Profil [Typ]	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor	Bell Shape tgn Indoor
(Relative) Loss [dB]:	19.9	14.2	16.3	21.2
Delay [ns]:	730	730	880	1050
AoA:	180.4	68.5	246.2	246.2

Tap:	Path 16		Path 17	Path 18
AS (A):	55	30.7	38.2	38.2
AoD:	183.7	291	62.3	62.3
AS (D):	55.2	33	38	38
Speed [km/h]	1.2	1.2	1.2	1.2
Distribution	Laplace	Laplace	Laplace	Laplace

A.20 802.11ac-MIMO Standards

According to IEEE 801.11-03/940r4

Rx Antenna Distance = 1

Tx Antenna Distance = 0.5

Distribution = Laplace

Profile = Bell Shape tgn Indoor, exception Model F, Path 3 where the Profile = Bell Shape tgn Moving Vehicle

Speed = 0.089 km/h, exception Model F, Path 3 where Speed = 40 km/h

A.20.1 Model A

Tap:	Path 1
Cluster	
Profil [Typ]	Bell Shape tgn Indorr
Loss [dB]	0
Delay [ns]	0
AoA	45
AS (A)	40
AoD	45
AS (D)	40
Speed [km/h]	0.089

A.20.2 Model B

Tap:	Path 1	Path 2	Path 3		Path 4	
Cluster			1	2	1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	0	5.4	10.8	3.2	16.2	6.3
Delay [ns]:	0	10	20	20	30	30
AoA:	4.3	4.3	4.3	118.4	4.3	118.4
AS (A):	14.4	14.4	14.4	25.2	14.4	25.2
AoD:	225.1	225.1	225.1	106.5	225.1	106.5
AS (D):	14.4	14.4	14.4	25.4	14.4	25.4
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 5		Path 6	Path 7	Path 8	Path 9
Cluster	1	2				
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	21.7	9.4	12.5	15.6	18.7	21.8
Delay [ns]:	40	40	50	60	70	80
AoA:	4.3	118.4	118.4	118.4	118.4	118.4
AS (A):	14.4	25.2	25.2	25.2	25.2	25.2
AoD:	225.1	106.5	106.5	106.5	106.5	106.5
AS (D):	14.4	25.4	25.4	25.4	25.4	25.4
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

A.20.3 Model C

Tap:	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Cluster						
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr

Tap:	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
(Relative) Loss [dB]:	0	2.1	4.3	6.5	8.6	10.8
Delay [ns]:	0	10	20	30	40	50
AoA:	290.3	290.3	290.3	290.3	290.3	290.3
AS (A):	24.6	24.6	24.6	24.6	24.6	24.6
AoD:	13.5	13.5	13.5	13.5	13.5	13.5
AS (D):	24.7	24.7	24.7	24.7	24.7	24.7
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 7	Path 7	Path 8	Path 8	Path 9	Path 9
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	13	5	15.2	7.2	17.3	9.3
Delay [ns]:	60	60	70	70	80	80
AoA:	290.3	332.3	290.3	332.3	290.3	332.3
AS (A):	24.6	22.4	24.6	22.4	24.6	22.4
AoD:	13.5	56.4	13.5	56.4	13.5	56.4
AS (D):	24.7	22.5	24.7	22.5	24.7	22.5
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 10	Path 10	Path 11	Path 12	Path 13	Path 14
Cluster	1	2				
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	19.5	11.5	13.7	15.8	18	20.2
Delay [ns]:	90	90	110	140	170	200
AoA:	290.3	332.3	332.3	332.3	332.3	332.3
AS (A):	24.6	22.4	22.4	22.4	22.4	22.4
AoD:	13.5	56.4	56.4	56.4	56.4	56.4
AS (D):	24.7	22.5	22.5	22.5	22.5	22.5

Tap:	Path 10	Path 10	Path 11	Path 12	Path 13	Path 14
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

A.20.4 Model D

Tap:	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
Cluster						
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	0	0.9	1.7	2.6	3.5	4.3
Delay [ns]:	0	10	20	30	40	50
AoA:	158.9	158.9	158.9	158.9	158.9	158.9
AS (A):	27.7	27.7	27.7	27.7	27.7	27.7
AoD:	332.1	332.1	332.1	332.1	332.1	332.1
AS (D):	27.4	27.4	27.4	27.4	27.4	27.4
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 7	Path 8	Path 9	Path 10	Path 11	
Cluster					1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	5.2	6.1	6.9	7.8	9	6.6
Delay [ns]:	60	70	80	90	110	110
AoA:	158.9	158.9	158.9	158.9	158.9	320.2
AS (A):	27.7	27.7	27.7	27.7	27.7	31.4
AoD:	332.1	332.1	332.1	332.1	332.1	49.3
AS (D):	27.4	27.4	27.4	27.4	27.4	32.1
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 12		Path 13		Path 14	
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	11.1	9.5	13.7	12.1	16.3	14.7
Delay [ns]:	140	140	170	170	200	200
AoA:	158.9	320.2	158.9	320.2	158.9	320.2
AS (A):	27.7	31.4	27.7	31.4	27.7	31.4
AoD:	332.1	49.3	332.1	49.3	332.1	49.3
AS (D):	27.4	32.1	27.4	32.1	27.4	32.1
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 15			Path 16		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	19.3	17.4	18.8	23.2	21.9	23.2
Delay [ns]:	240	240	240	290	290	290
AoA:	158.9	320.2	276.1	158.9	320.2	276.1
AS (A):	27.7	31.4	37.4	27.7	31.4	37.4
AoD:	332.1	49.3	275.9	332.1	49.3	275.9
AS (D):	27.4	32.1	36.8	27.4	32.1	36.8
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 17		Path 18
Cluster	2	3	
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	25.5	25.2	26.7
Delay [ns]:	340	340	390
AoA:	320.2	276.1	276.1

Tap:	Path 17		Path 18
AS (A):	31.4	37.4	37.4
AoD:	49.3	275.9	275.9
AS (D):	32.1	36.8	36.8
Speed [km/h]	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace

A.20.5 Model E

Tap:	Path 1	Path 2	Path 3	Path 4	Path 5	
Cluster					1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	2.6	3	3.5	3.9	4.5	1.8
Delay [ns]:	0	10	20	30	50	50
AoA:	163.7	163.7	163.7	163.7	163.7	251.8
AS (A):	35.8	35.8	35.8	35.8	35.8	41.6
AoD:	105.6	105.6	105.6	105.6	105.6	293.1
AS (D):	36.1	36.1	36.1	36.1	36.1	42.5
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 6		Path 7		Path 8	
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	5.6	3.2	6.9	4.5	8.2	5.8
Delay [ns]:	80	80	110	110	140	140
AoA:	163.7	251.8	163.7	251.8	163.7	251.8
AS (A):	35.8	41.6	35.8	41.6	35.8	41.6
AoD:	105.6	293.1	105.6	293.1	105.6	293.1
AS (D):	36.1	42.5	36.1	42.5	36.1	42.5

Tap:	Path 6		Path 7		Path 8	
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 9			Path 10		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	9.8	7.1	7.9	11.7	9.9	9.6
Delay [ns]:	180	180	180	230	230	230
AoA:	163.7	251.8	80	163.7	251.8	80
AS (A):	35.8	41.6	37.4	35.8	41.6	37.4
AoD:	105.6	293.1	61.9	105.6	293.1	61.9
AS (D):	36.1	42.5	38	36.1	42.5	38
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 11			Path 12		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	13.9	10.3	14.2	16.1	14.3	13.8
Delay [ns]:	280	280	280	330	330	330
AoA:	163.7	251.8	80	163.7	251.8	80
AS (A):	35.8	41.6	37.4	35.8	41.6	37.4
AoD:	105.6	293.1	61.9	105.6	293.1	61.9
AS (D):	36.1	42.5	38	36.1	42.5	38
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 13			Path 14		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	18.3	14.7	18.6	20.5	18.7	18.1
Delay [ns]:	380	380	380	430	430	430
AoA:	163.7	251.8	80	163.7	251.8	80
AS (A):	35.8	41.6	37.4	35.8	41.6	37.4
AoD:	105.6	293.1	61.9	105.6	293.1	61.9
AS (D):	36.1	42.5	38	36.1	42.5	38
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 15				Path 16		Path 17	Path 18
Cluster	1	2	3	4	2	4	4	4
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	22.9	19.9	22.8	20.6	22.4	20.5	20.7	24.6
Delay [ns]:	490	490	490	490	560	560	640	730
AoA:	163.7	251.8	80	182	251.8	182	182	182
AS (A):	35.8	41.6	37.4	40.3	41.6	40.3	40.3	40.3
AoD:	105.6	293.1	61.9	275.7	293.1	275.7	275.7	275.7
AS (D):	36.1	42.5	38	38.7	42.5	38.7	38.7	38.7
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089
Distribu-tion	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

A.20.6 Model F

Tap:	Path 1	Path 2	Path 3	Path 4	Path 5	
Cluster					1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Moving Vehicle	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	3.3	3.6	3.9	4.2	4.6	1.8
Delay [ns]:	0	10	20	30	50	50
AoA:	315.1	315.1	315.1	315.1	315.1	180.4
AS (A):	48	48	48	48	48	55
AoD:	56.2	56.2	56.2	56.2	56.2	183.7
AS (D):	41.6	41.6	41.6	41.6	41.6	55.2
Speed [km/h]	0.089	0.089	40	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 6		Path 7		Path 8	
Cluster	1	2	1	2	1	2
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	5.3	2.8	6.2	3.5	7.1	4.4
Delay [ns]:	80	80	110	110	140	140
AoA:	315.1	180.4	315.1	180.4	315.1	180.4
AS (A):	48	55	48	55	48	55
AoD:	56.2	183.7	56.2	183.7	56.2	183.7
AS (D):	41.6	55.2	41.6	55.2	41.6	55.2
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 9			Path 10		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	8.2	5.3	5.7	9.5	7.4	6.7

Tap:	Path 9			Path 10		
Delay [ns]:	180	180	180	230	230	230
AoA:	315.1	180.4	74.7	315.1	180.4	74.7
AS (A):	48	55	42	48	55	42
AoD:	56.2	183.7	153	56.2	183.7	153
AS (D):	41.6	55.2	47.4	41.6	55.2	47.4
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 11			Path 12		
Cluster	1	2	3	1	2	3
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	11	7	10.4	12.5	10.3	9.6
Delay [ns]:	280	280	280	330	330	330
AoA:	315.1	180.4	74.7	315.1	180.4	74.7
AS (A):	48	55	42	48	55	42
AoD:	56.2	183.7	153	56.2	183.7	153
AS (D):	41.6	55.2	47.4	41.6	55.2	47.4
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089
Distribu-tion	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 13				Path 14			
Cluster	1	2	3	4	1	2	3	4
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	14.3	10.4	14.1	8.8	16.7	13.8	12.7	13.3
Delay [ns]:	400	400	400	400	490	490	490	490
AoA:	315.1	180.4	74.7	251.5	315.1	180.4	74.7	251.5
AS (A):	48	55	42	28.6	48	55	42	28.6
AoD:	56.2	183.7	153	112.5	56.2	183.7	153	112.5
AS (D):	41.6	55.2	47.4	27.2	41.6	55.2	47.4	27.2

Tap:	Path 13				Path 14			
Speed [km/h]	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089
Distribu-tion	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 15				
Cluster	1	2	3	4	5
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	19.9	15.7	18.5	18.7	12.9
Delay [ns]:	600	600	600	600	600
AoA:	315.1	180.4	74.7	251.5	68.5
AS (A):	48	55	42	28.6	30.7
AoD:	56.2	183.7	153	112.5	291
AS (D):	41.6	55.2	47.4	27.2	33
Speed [km/h]	0.089	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace	Laplace

Tap:	Path 16		Path 17	Path 18
Cluster	2	5	6	6
Profil [Typ]	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr	Bell Shape tgn Indorr
(Relative) Loss [dB]:	19.9	14.2	16.3	21.2
Delay [ns]:	730	730	880	1050
AoA:	180.4	68.5	246.2	246.2
AS (A):	55	30.7	38.2	38.2
AoD:	183.7	291	62.3	62.3
AS (D):	55.2	33	38	38
Speed [km/h]	0.089	0.089	0.089	0.089
Distribution	Laplace	Laplace	Laplace	Laplace

A.21 802.11ac-SISO Standards

These fading profiles are implemented as the IEEE 802.11ac-MIMO models, expect that:

- Correlation Path = Off

- Coefficient, % = 100
- Phase, deg = 0

See chapter A.20, "802.11ac-MIMO Standards", on page 269.

A.22 802.11p Channel Models

According to C2C-CC TF Antennae & Wireless Performance – Whitepaper Vs 1.0

- Fading Profile = Custom
- Doppler Shape = Rayleigh
- Bandwidth = 2*abs(f_d)
- Frequency Offset = 0 Hz
- for fd > 0:
  - Lower Cutoff Frequency = 0
  - Upper Cutoff Frequency = f_d

  for fd < 0:
  - Lower CutOff Frequency = -f_d
  - Upper CutOff Frequency = 0

A.22.1 Rural LOS

This channel model is intended primarily as a reference result. It applies in very open environments where other vehicles, buildings and large fences are absent.

	Path 1	**Path 2**	**Path 3**
Profile [Type]	Static	Custom	Custom
(Relative) Loss [dB]:	0	14	17
Delay [ns]:	0	83	183
f_D [Hz]	0	492	-295

A.22.2 Urban Approaching LOS

Two vehicles approaching each other in an urban setting with buildings nearby.

	Path 1	**Path 2**	**Path 3**	**Path 4**
Profile [Type]	Static	Custom	Custom	Custom
(Relative) Loss [dB]:	0	8	10	15

	Path 1	Path 2	Path 3	Path 4
Delay [ns]:	0	117	183	333
f_D [Hz]	0	236	-157	492

A.22.3 Urban Crossing NLOS

Two vehicles approaching an Urban blind intersection with other traffic present. Buildings/fences present on all corners.

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Static	Custom	Custom	Custom
(Relative) Loss [dB]:	0	3	5	10
Delay [ns]:	0	267	400	533
f_D [Hz]	0	295	-98	591

A.22.4 Highway LOS

Two cars following each other on Multi-lane inter-region roadways such as German autobahns and USA Interstates. Signs, overpasses, hill-sides and other traffic present.

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Static	Custom	Custom	Custom
(Relative) Loss [dB]:	0	10	15	20
Delay [ns]:	0	100	167	500
f_D [Hz]	0	689	-492	886

A.22.5 Highway NLOS

As for Highway LOS but with occluding trucks present between the vehicles.

	Path 1	Path 2	Path 3	Path 4
Profile [Type]	Static	Custom	Custom	Custom
(Relative) Loss [dB]:	0	2	5	7
Delay [ns]:	0	200	433	700
f_D [Hz]	0	689	-492	886

B Antenna Pattern File Format

Antenna pattern files are xml files in the Rohde&Schwarz proprietary antenna pattern file format. These files use the predefined file extension `*.ant_pat`. They describe the antenna pattern as an array with typical resolutions of 1 to 5 degree for both the elevation and azimuth angels. Antenna pattern files contain the loss values for a given azimuth and elevation pair.

For an isotropic antenna for instance, that radiates the energy equally in all directions, the array elements are all 0 dB.

Example: Antenna with three sectors (3Sectors.ant_patt) - extract

The following is an examples of the file format. It shows an extract of the description of an antenna pattern with three sectors, as this is specified by 3GPP TR 25.996.

According to this specification, the 3 sector antenna pattern should be used for each sector. The antenna pattern is specified by the following equation:

$A(\Theta) = -\min[12(\Theta/\Theta_{3dB})^2, A_m]$

Where:

- $-180° \leq \Theta \leq 180°$ is the angle between the direction of interest and the boresight of the antenna
- Θ_{3dB} is the 3dB beamwidth in degrees
- A_m is the maximum attenuation

For the 3 sector scenario Θ = 70 deg and A_m = 40 dB.

Note: The antenna pattern files define the antenna power and not the antenna gain.

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<antenna_pattern>
  <antenna_descr count="1">
    <antenna id="1" RollAxis_X_offset="0" PitchAxis_Y_offset="0"
                    YawAxis_Z_offset="0" Yaw_offset="0"
                    Pitch_offset="0" Roll_offset="0"/>
 </antenna_descr>
    <az_res> 1.00000000e+000 </az_res>
    <elev_res> 1.00000000e+000 </elev_res>
 <data>
     -179.5,-178.5,-177.5,...   -89.5,   -88.5,   -87.5,   -86.5,...178.5,180.5
-89.5,   40,    40,    40,...3.92e+01,3.84e+01,3.75e+01,3.66e+01,...   40,40
  </data>
</antenna_pattern>
```

The table 2-1 describes the used tags and parameters.

Table 2-1: Format of *.ant_pat file

Container	Tag name	Parameter	Description
<antenna_pattern>			Defines antenna pattern File
<antenna_descr>			Contains the descriptions of the antennas

Container	Tag name	Parameter	Description
		<count>	Number of antenna patterns; Value = 1 always
	<antenna>		Descriptions of the individual antenna
		<id>	Antenna identification number
		<YawAxis_Z_offset> <PitchAxis_Y_offset> <RollAxis_X_offset>	(currently not used but reserved for future use) Position shift of the antenna along the X/Y/Z axis with respect to the center of gravity of the body Value in meters
		<Yaw_offset> <Pitch_offset> <Roll_offset>	(currently not used but reserved for future use) Angular shift of the antenna along the X/Y/Z axis of the to the body Value in degrees
<az_res>			Resolution of the columns in the data section value in degrees integer divider of 360
<elev_res>			Resolution of the rows in the data section value in degrees integer divider of 180
<data>			Represents the power response of the antenna; the power loss values are in dB (between 0 and 40) The file has to contain for every pattern: • [1 + 360/<az_res>] columns • [1 + 180/<elev_res>] rows

Glossary: Fading Simulator: Specifications, References, Further Information

Symbols

[1]: http://www.ist-winner.org

[2]: Laurent Schumacher, et al, "Closed-Form Expressions for the Correlation Coefficient of Directive Antennas Impinged by a Multimodal Truncated Laplacian PAS" IEEE Transactions on wireless communications, P.1351-1359, Vol. 4, No. 4, 2005

3GPP 37.977: "Verification of radiated multi-antenna reception performance of User Equipment (UE)"

3GPP TR 25.996: Spatial channel model for Multiple Input Multiple Output (MIMO) simulations

T

TGac: IEEE 802.11-09/0308r3
IEEE P802.11 Wireless LAN "**TGac** Channel Model Addendum"

TGn: IEEE 802.11-03/940r
IEEE P802.11 Wireless LAN "**TGn** Channel Models"

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